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FREEDOM AND RESPONSIBILITY IN SCIENCE

AT least three factors in recent months have raised anew the problem of the conditions of scientific work and particularly freedom of investigation and of publication. Sir Hartley Shawcross has testified to the vital importance of a free Press, but even his reassuring statement on behalf of the Government does not entirely remove concern on this point. Moreover, in view of the complexity of most public affairs to-day and the growing extent to which technical and scientific factors determine the success or failure of policy and plans, the need for independent and impartial criticism was never greater.

A large part of the responsibility for such criticism must fall on men of science and technologists; but, if they are to discharge that trust, they must not only be assured of a vehicle of expression but also of full information on which to base sound opinion. It is because the means of forming such opinion are restricted or denied that there is widespread uneasiness to-day. The public corporations are an example, and if the groundnut scheme of the Overseas Food Corporation provides the worst example, it is only true to type. Atomic energy is a further example with which the Atomic Scientists Association in particular has been concerned.

Concern has been freely expressed in Great Britain about the possible effects of secrecy in nuclear research on the advancement of science in other fields, although no such situation has yet arisen comparable with that which has followed the inclusion in the 1950 Independent Offices Appropriation Act passed by Congress last August of the provision for loyalty and security investigation of all Atomic Energy Commission 'fellows'. Subsequent discussions within the U.S. National Academy of Sciences and the National Research Council revealed almost unanimous opposition to the application of clearance procedures to those working in fields which are not secret. The Academy accordingly recommended that the National Research Council should not accept the responsibility for administering the altered fellowship programme, and urged the Atomic Energy Commission to take all proper steps to see that these restrictive provisions are omitted from future legislation. The Atomic Energy Commission believes that any fellowship programme affecting a substantial number of students training in broad and established fields of science should be administered by a scientific or educational organisation. Further, it would be extremely difficult to administer an effective fellowship programme which did not receive the full support of the scientific community. Under these conditions, the Atomic Energy Commission has drastically reduced its fellowship programme. No new pre-doctoral fellowships will be offered for 1950–51, and post-doctoral fellowships will be limited to work requiring secret information. It is expected that about 75 new awards will be offered and about 175 renewals granted as against a present total of 421 fellows, of whom only 30 are engaged in secret work.

That position is sufficient to illustrate the way in which secrecy requirements may affect the conduct of research. It is well known that, with the passing by Congress of the provision in question, there was a marked falling off in the quality of applicants for fellowships. In Australia, too, Dr. I. W. Wark has expressed concern that acceptance by the universities of contracts for secret defence research may endanger their independence; while others besides Sir David Rivett are concerned lest the new status of the Commonwealth Scientific and Industrial Research Organisation should prove detrimental to the establishment of the atmosphere in which scientific research flourishes.

The third source of concern is provided by the genetics conflict in the Soviet Union. That the Russian Government has attacked the very intellectual liberties which make scientific research possible is sufficiently serious; but for a major nation to over-ride, even in a particular field such as genetics, the basic scientific appeal to facts by ideological considerations does not mean simply, as Dr. Julian Huxley has pointed out, the repudiation of certain basic elements of scientific method; it means also the repudiation of the universal and supra-national character of science. Nor can we any longer believe that this threat to the freedom and unity of science is confined to Russian territory.

No matter which of these three factors has stimulated our interest, the freedom of science is no isolated question. It is one facet of the wider problem of the preservation of a free society. Freedom of utterance and publication for the man of science is an essential part, for example, of that larger question of freedom of the Press, of the right to know and to utter freely and to expose threats to civil liberty or the general welfare, whether or not they are due to encroachments by the central executive or to errors of judgment by public or private bodies. So, too, the question of secrecy cannot be resolved save as we take a clear and realistic view of the requirements of national defence and security as well as of the conditions which favour scientific research. There is required the positive view of security which Sir David Rivett has emphasized; we must look primarily to achievement and not to negative restraint, and we must seek to formulate our conception of the freedom of science in the context not only of responsibility for creative work, but also of responsibility for the well-being of a society in which scientific effort is an essential element.

From this point of view it is important that scientific workers generally should consider more fully the wider issues raised by this question of human rights, whether in the specific form in which it is presented by the clash over the civil liberties of scientific men in the United States in regard to the Atomic Energy Commission fellowships, or by the essays on the scientific aspects of human rights contributed to the symposium published recently by the United Nations Educational, Scientific and Cultural Organisation. In this connexion the conclusions and recommendations of the special committee appointed by the Council of the American Association for the Advancement of Science deserve attention, although they were limited to three main questions: restrictions on research and scientific information; measures to assure the personal reliability of scientific men having access to confidential data; and inquiries relating to the 'loyalty' of scientific workers in Federal employment. The Committee nevertheless seized the opportunity to point out that secrecy is damaging to both science and democracy and fully endorsed an important passage in the third volume of the Report on Science and Public Policy (see *Nature*, **162**, 673; 1948), dealing with Administration for Research. Discussing the three key questions of planning and research, professional compatibilities and scientific freedom and national security, the Steelman Committee said: "Strict military security in the narrow sense is not entirely consistent with the broader requirements of national security. To be secure as a Nation we must maintain a climate favourable to the full flowering of free inquiry. However important secrecy about military weapons may be, the fundamental discoveries of researchers must circulate freely to have beneficial effect." In its first volume the Committee urged that, in the long run, national security depends far more upon the nation's total scientific potential than upon any other consideration.

In the view of the Steelman Committee, with which the Committee on Civil Liberties concurs, security regulations should be applied only when strictly necessary, and should then be limited to specific instruments, machines or processes. It is when they are left vague that they may be construed to cover basic principles of fundamental knowledge, and that is why the view of the defence authorities in Australia, for example, gives rise to uneasiness. If the degree of freedom of fundamental and applied research is governed by the requirements of national defence and does not depend on specific projects which can be clearly defined, no continuous review of restrictions on either publication or the prosecution of research can avoid being detrimental—particularly in discouraging the most creative and fertile minds from working in such fields.

Assuming, however, that the area of secrecy has been clearly defined—and at the minimum consistent with the requirements of national policy—the Committee on Civil Liberties for Scientists admits that the reliability of those persons to whom these matters are entrusted must be assured. Nevertheless, it is extremely critical of the present organisation for conducting inquiries into the character and attitudes of the scientific workers affected; not only are there procedural and administrative defects, but also the inquiries are applied far too widely. The excessive precautions discourage participation in important research activities closely linked to the national welfare, and the delays and expense often involved deter qualified persons from entering the atomic energy programme. The Committee rightly observes that work in this field will be shunned by men of ability and pride if they are constantly treated as objects of suspicion and possibly calumny.

Of the Loyalty Order, the Committee is even more critical. This Order is objectionable, in the view of

the Committee, because it seeks to determine the employee's loyalty by inquiring into his supposed thoughts and attitudes, which are established in large part by imputing to him the beliefs of his associates. Instead, attention should be focused on his behaviour in overt acts. In so far as the Loyalty Order purports to deal with such matters as espionage, sabotage and disregard of instructions, it is wholly superfluous. Criminal conduct of that character is already subject to administrative disciplinary action under existing law and regulations. The failure to confine the Loyalty Order to matters of objective proof has engendered a feeling of insecurity in public employment, and may be expected to lessen the vigorous intellectual independence which is a prime condition of sound scientific work as it is of an imaginative Civil Service.

These conclusions of the American committee are of profound interest elsewhere. The Committee formulating them was fully aware of the difficulties of the situation and that no easy solution would be found. It put its finger on the defective character of the very concepts which the Loyalty Order expresses, and more than anything else the findings of the Committee demonstrate the need for some fundamental and imaginative thinking on the administrative side if the scientific effort of the nation is not to suffer.

But such fundamental and imaginative thought is demanded of the scientific worker also, and, in his contribution to "Human Rights", R. W. Gerard makes an attempt to indicate how a biological approach could help in the discovery of what human rights in the present situation might be. Such a positive approach is essential, and Mr. Gerard does not merely remind us that such rights are relative to society and that sometimes rights must be abrogated as new ones are demanded. He points to the greater dependence of the individual on the group, and at the same time to the falseness of any doctrine which regards man only as an individual or only as a unit in a group. We cannot escape the duality of man as an individual and as a social unit, and accordingly the extremes of individualism and collectivism, anarchism and totalitarianism, *laissez faire* and absolute economic socialism are untenable.

The biological approach upholds the view that the rights of man involve rights of the individual (or small group) as against other individuals (or groups) or the whole of society, and duties are correspondingly implied; just as, conversely, there are rights—and duties—of the whole or the whole group as against the individual. To work out the implications of freedom of science itself at the national level involves thinking out the implications and relations at the level of the professional association or even at the level of the smaller groups comprised in any such association or working unit. Even at that level, it is possible to think that Mr. Gerard is a little optimistic in thinking that altruism is growing relative to selfishness, and control is being exercised relatively ever more by suasion as compared to force.

Dr. J. M. Burgers recognizes that only by the free and open contest of opinions formed in as many and as diverse minds as possible can we avert the danger that our society will run in directions which will bring an end to all creativeness; but, in his discussion of the dangers which attend the introduction of legal secrecy restrictions into science, the most important point he makes is the duty of the scientific worker to help the public to understand the meaning and importance of scientific findings. That this duty has been imperfectly discharged may well be one reason for the excessive restrictions which Congress has imposed in the United States on work in the atomic energy field. This is all the more important because, as Dr. Burgers notes, there is always risk of misunderstanding and even misuse of every expression of truth, owing to the limitations of the minds which frame such expression.

Nevertheless, for all this qualification, Dr. Burgers's formulation of the duties and rights of creative expression seems at least a little too dogmatic, and scarcely admits of the conditioning which may be required by relations between individuals and smaller and larger groups. His claims for freedom of scientific intercourse and publication, and free access to published material, are too sweeping; and, like his repudiation of all secrecy restrictions upon scientific research or its publication for competitive purposes, are open to abuse. The question of responsibility is vital but is virtually ignored; although he does insist on the responsibility of the scientific man in the matter of furthering the understanding of the implications of science and the possibilities flowing from the application of science.

The question of responsibility is much more closely examined, however, by Dr. B. J. Bok, himself a member of the Committee on Science and its Social Relations of the International Council of Scientific Unions, in an article on "Freedom of Science and the Universal Declaration of Human Rights" in the *Bulletin of the Atomic Scientists* of August–September. Dr. Bok clearly recognizes the way in which the freedom of science is only one aspect of human freedom in general and depends upon the existence in world opinion of a 'climate' favourable to it. He recognizes, too, that the main danger to the freedom of science in the West is not so much direct attack as insidious and unnoticed encroachments under changing conditions of modern life, and that the first need is unceasing vigilance and the willingness of scientific men to protest vigorously and promptly against all attempts to infringe these freedoms.

Scientific workers can no longer take for granted any particular freedom, whether of investigation, of utterance or of movement, vital as they are to the interplay of minds upon which intellectual advance depends. It is not sufficient for them to protest against infringements of such freedom: they must rather seek to secure the support and understanding of their fellow citizens by making known the reason for their protests, and by showing just how it is that, without freedom, society cannot hope to reap the full benefit of the work of either individuals or of the vast body of existing knowledge. A sense of public responsibility must be available to support their protests.

That is the spirit in which Dr. Bok has formulated a revised personal version of the charter for scientific workers, which attempts to meet some of the criticisms of the draft originally suggested by the Committee on Science and its Social Relations in 1948. Dr. Bok limits the rights he claims for scientific men to three principal ones: the right to participate freely in all activities permitted to the average citizen; the right to obtain general information about the purposes of designed projects; and the right to publish the results of researches and to discuss work in progress with fellow workers, except where these privileges may have to be restricted for socially or ethically justifiable reasons.

These rights, however, should be considered in the light of the obligations which they entail on the scientific man himself, though even so it must be admitted that it would be necessary to give clear meaning to some of the phrases before they could be generally accepted. There may well be a wide field for difference of opinion as to what constitutes socially or ethically justifiable reasons. Again, it may be taken for granted that it is the duty of every scientific man to maintain a spirit of honesty, integrity and co-operation, to promote the development of science in the ways most beneficial to mankind and, so far as possible, to prevent its misuse, to assist in the education of the people and of governments in the aims, methods and spirit of scientific research, to promote international collaboration in science, to work for the preservation of world peace, to contribute towards a spirit of world citizenship and to emphasize and develop the human values associated with science and technology; but not every one could accept without reservation or further definition the obligation which Dr. Bok puts second, namely, to examine searchingly the meaning and purposes of the work he or she is performing, and, when in the employ of others, to inquire into those purposes and to evaluate the moral issues that may be involved. That is a responsibility not lightly to be undertaken, nor easily discharged without detriment to the individual or to science itself. Subject to the qualification that the spirit of honesty, integrity and co-operation is maintained and that the examination is in the mind of the man and not a cloak for prying into extraneous affairs of his employer, whoever that may be, it may come nearer to acceptance than in its original form. The difference, however, appears to be slight, and it is rather in the spirit of Dr. Bok's article that some advance on the original suggestions can be discerned. He focuses attention sharply on the problems that are yet to be solved, and, while he advances no more than tentative suggestions for solving some of them, he displays clearly the challenge which the present situation throws down to all who are concerned with the advance of science and the welfare of mankind. Progress in science will be made in the future, as it has always been, by the free mind, left to its own working; but the conditions under which science is free can only be secured to-day when the goodwill and understanding of the whole community are enlisted in their defence.

MATHEMATICAL BIOPHYSICS

Mathematical Biophysics

By N. Rashevsky. Revised edition. Pp. xxiii+669. (Chicago: University of Chicago Press; London: Cambridge University Press, 1948.) 7.50 dollars.

ABOUT half of this revised edition is reprinted with little change from the first edition of 1938. Some of the remaining chapters appeared in Rashevsky's "Advances and Applications of Mathematical Biology" (1940) and other publications, while the rest are new. As a result, the style is uneven and some of the chapters are out of date. An example of the latter is the treatment of nerve conduction, in which no account is taken of the capacity of the surface membrane.

The first three sections of the book cover the same ground as the first edition. In the first section, Rashevsky develops a theory of the stability, growth and division of cells, which depends on osmosis and the forces due to diffusion fields. The second deals with excitation and conduction in nerve fibres, while in the third he suggests mechanisms by which simple elements in the central nervous system might be combined to do some of the things of which the brain is capable. The fourth section deals with the form and movement of the whole organism and is reminiscent of D'Arcy Thompson's "Growth and Form". It ends with a chapter on "The Organic World as a Whole", in which equations are given (but not solved) governing the course of evolution.

The expressed intention of this book is to "lay the first stone" of "a mathematical biology which would stand in the same relation to experimental biology as mathematical physics stands to experimental physics". Rashevsky also says in the introduction that the mathematical natural sciences "should not be made mere handmaidens of the experimentalist". One can scarcely quarrel with these opinions; but the book loses much of its value, at any rate for the experimentalist, through thus asserting the theorist's independence. Each of Rashevsky's wide range of topics is developed on a single set of assumptions, and in most cases the treatment will be valueless if the assumptions turn out to be wrong. No help is given to the experimenter who may wish to test the assumptions; alternative hypotheses are not developed, and the author does not point out how far the results depend on particular features of the assumptions. There are a fair number of graphs showing agreement between the theoretical formulæ and experimental results obtained by others; but they are not presented in a way which enables one to judge whether they really support the theory. In one case at least (p. 39), totally unjustified conclusions are reached through using a fallacious procedure for curve-fitting.

The book is not easy to read. In each chapter, assumptions and definitions of symbols are introduced piecemeal, and results are usually given only as equations. Hence one cannot even discover what is attempted without reading the chapter from beginning to end. The book does, however, contain much that is interesting and stimulating, particularly in the section on the central nervous system. Most of its faults are the direct result of attempting, over a wide field, a synthesis for which an adequate experimental basis does not yet exist.

A. F. HUXLEY

ANIMALS ON PARADE

The Story of Animal Life

By Dr. Maurice Burton. Vol. 1: The Framework of Animal Life; Invertebrates. Pp. xii+381. Vol. 2: Vertebrates. Pp. viii+423. (London: Elsevier Publishing Co., Ltd., 1949.) 63*s*.

HERE is a survey of the entire animal kingdom, produced and illustrated in a luxurious fashion, and written mainly by Dr. Maurice Burton, deputy keeper of zoology in the British Museum (Natural History) and one of Britain's leading exponents of animal biology. Other zoologists contributed articles under the editorship of Dr. Burton. These include: Dr. W. E. Swinton, Mr. T. H. Savory, Dr. G. Crile, Dr. D. Dilwyn John, Prof. M. W. de Laubenfels, Dr. J. D. Ommaney, Dr. Ben Dawes, Dr. T. Mortensen, Dr. J. P. Harding, Dr. S. M. Manton, Dr. T. E. Snyder, Dr. C. H. Curran, Prof. G. D. Hale Carpenter, Dr. G. Barendrecht, Mr. G. Nixon, Prof. L. Bertin, Dr. C. M. Bogert, Mr. E. G. Turbott, Mr. D. Goodwin, Mr. B. East, Mr. K. W. Kenyon, Mr. W. Van Riper, Dr. W. R. Philipson, Dr. J. E. Hill, Mr. D. Fleay, Lotus and Margery Milne, Prof. W. H. Hodge, Mr. L. W. Walker, Mr. H. W. Nissen and Dr. Ida M. Mellen—an impressive list of names, but then this is an impressive work. The late Mr. W. P. Pycraft left a number of notes which the editor was able to utilize in the preparation of Vol. 2.

The two volumes are packed with photographs, most of them large ones, of a very high standard in art and animal portraiture. For example, the six pictures depicting commensalism and showing a hermit crab moving from one protective shell to another, to be followed soon afterwards by two sea anemones, are nothing short of superb. The close-up photograph of a praying mantis with a wasp gripped in its powerful fore-legs is an example of Nature photography at its best. There are more than a thousand such photographs, some of them full-page; and both volumes are decorated with a few full-page colour-photographs. Some distribution maps are also included.

The text makes good reading since unnecessary technical terms are omitted, and, though there are many authors, Dr. Burton has done well in keeping the style flowing and consistent.

The subject material has an evolutionary background—the best method of approach in a survey of this kind. Classification, structure and, above all, behaviour, are closely studied. With this object in view, most of the many illustrations are of living animals in action. Having an evolutionary trend, the book must be based on the beginnings and framework of animal life. So there are chapters of the origin, mechanism, history, expression and background of life, followed by a survey of life in and under the sea. These chapters open up Vol. 1, and are followed by seventeen chapters on invertebrates, including seven on the insects. Vol. 2 deals with vertebrates, beginning with some of their forerunners, such as sea squirts and lancelets, etc. In this volume there are twenty-five chapters, seven of which are devoted to birds and eight to mammals. One chapter deals entirely with the psychology of apes. A final chapter is devoted to domesticated animals; but it is a pity that here the text is confined to animals domesticated in countries of the temperate regions, because the book itself deals with animals of the entire world.

This work can be strongly recommended. The very excellence of its illustrations and production in general will appeal to many categories of book-lovers. It is a valuable work of reference, having both systematic and subject indexes (though it is difficult to see why these should be in the reverse order in Vol. 2 compared with Vol. 1). Finally, all students of biology (especially degree students of zoology who have to spend so much of their time on comparative anatomy and not enough on animal behaviour, not to mention physiology) could not do better than get hold of these two volumes, for they are books to have as one's own.

Just a note for the publisher. Vol. 1 deals mainly with invertebrates. Why, therefore, use a photograph of a vertebrate (the lesser anteater, taken from Vol. 2) as the design of the book-jacket of Vol. 1, and another vertebrate (a bird) for the blind blocking on the front cover? Invertebrate *motifs* for the jacket and cover of Vol. 1 would render identification of the volumes easier, especially since the numbers and sub-titles appear only on the spine of each volume.

L. J. F. BRIMBLE

STATIC TRANSFORMERS AND SYNCHRONOUS ALTERNATORS

Les machines électriques des réseaux

Par R. Langlois-Berthelot. Pp. 267. (Paris: Éditions Eyrolles, 1949.) 1700 francs.

THE main plant components of alternating-current systems are alternators and transformers. These machines have been developed in the course of half a century to a remarkable degree of efficiency and reliability, as may be judged from the fact that units exceeding 100,000 kVA. in capacity are beginning to be commonplace. Their working principles are familiar to all electrical engineers and to large numbers of radio amateurs, so that it may appear superfluous to take notice of another book about them. The main justification for doing so is the vast extent to which alternators and transformers are used in providing vital supplies of power and energy. More than one thousand alternators operate in parallel on the British grid system, and many more transformers of large capacity link the generating systems with the interconnecting network.

The transformers are exposed to two main hazards: over-stressing of insulation by lightning strokes to the overhead power lines, and mechanical stresses resulting from short-circuits on the system. The impulsive stresses due to lightning are of the order of 600,000 volts, and the mechanical stresses on short-circuit can reach about a hundred times the normal full-load values. In addition, it is now customary to provide 'on-load' voltage-control equipment in the main transformers, so that they have lost their early simplicity and can justifiably be termed machines. Further complications may also be introduced for phase control, phase transformation, and to provide interconnexion between three or more systems in one unit. Current and voltage transformers used for supplying instruments and protective relays which are so commonplace at low voltages become the most expensive item of a power system per unit of useful output when the system voltage exceeds about 100,000 volts. The problem of finding a more economical method of supplying these small powers is

an important one in the development of A.C. transmission. Alternators, too, have become more complicated by the introduction of hydrogen cooling and special excitation devices to obtain maximum stability of operation with machines of minimum weight per unit of output.

R. Langlois-Berthelot gives a clear and interesting account of both classes of plant, which is designed to serve advanced students in technical schools and engineers who have to operate and maintain such plant. He puts his wide experience as a constructor and as a system engineer frankly at the service of his readers, and it would be difficult to find so much practical information in any other single volume. As it is impossible entirely to segregate the problems involved in operating alternators and transformers on an interconnected network, he concludes with an introduction to the study of such networks. This outlines the problems of steady-state operation, short-circuit conditions, stability, surge voltages, power-flow regulation, and optimum utilization of plant from the point of view of duration of life.

All who are concerned with large-scale electricity supply will find the author's treatment to be eminently practical and stimulating. His method, which uses more words than illustrations, will not appeal to many British engineers; but it is not without merit when the words are skilfully used, as is the case in this instance.

C. W. MARSHALL

THEORY OF METALS FOR THE PRACTICAL METALLURGIST

Electrons, Atoms, Metals and Alloys

By Dr. William Hume-Rothery. Pp. 377. (London: Iliffe and Sons, Ltd., 1948.) 25*s*. net.

THIS book has been written with a particular purpose—to introduce the latest advances in the theory of metals to the practical metallurgist. No one could be better suited to this task than Dr. W. Hume-Rothery, who has made so many important contributions to the subject, and who has yet kept his feet firmly planted on the ground of experimental work. In order to be able to lay stress on the more difficult points, and to anticipate difficulties that may arise in the mind of the practical metallurgist, the author has written the book in the form of a dialogue between a "Young Scientist" (a very able fellow) and an "Older Metallurgist" (a remarkably intelligent person who knows all the right questions to ask).

It is doubtful, however, whether the book will serve the purpose intended; the range of subject-matter is so wide that the ordinary reader, having been conducted through the maze of the electronic structures of the elements (all of them), wave mechanics, free-electron theory, Brillouin zones, electron compounds and nuclear physics, may well be almost as bewildered at the end of the book as at the beginning. Pruning would probably improve the book considerably; general principles could have been emphasized at the expense of completeness, and some sections, such as those on plastic deformation and nuclear physics, could have been omitted completely.

However, it is quite possible that the book will be of considerable value to people other than those for whom it is intended. Those who still find a mental picture useful in absorbing new ideas—and if, in addition, they have to deal with students of the same frame of mind—may often be glad to have this book to turn to for reference. Theorists may protest that the representations are often too precise, but, nevertheless, they are better than the complete absence of representation that many people would have to be content with if they had to rely upon the mathematics alone.

After these general comments, it may seem odd to pick out a single sentence for comment. But why, on p. 64, has Dr. Hume-Rothery stated so emphatically, and apparently unnecessarily, that "It is not the province of Science to answer the question 'Why ?' " ? How much of modern science would have existed had not so many people been actuated by this word ?

MONOGRAPH ON THE BANANA

Bananas

Chemistry, Physiology, Technology. By Harry W. von Loesecke. (Economic Crops, Vol. 1.) Pp. xi+189. (New York and London: Interscience Publishers, Inc., 1949.) 36*s*.

THIS is the first of a series of volumes in which food crops will be given monographic treatment, special attention being paid to their chemical composition and biochemical aspects. This venture, which is justified by the accumulation of analytical data during recent decades, has much to commend it and will be appreciated by those who have to cope with the rapidly growing, but varied and often scattered, literature relating to the major crops. In general, the aim is to assemble and integrate research data relating to the many aspects of the production and the utilization of crops.

In this volume the author has cast his net widely, and within less than two hundred pages has dealt in some detail with the many interesting themes and problems presented by the banana—a major tropical crop and one requiring special care during the post-harvesting phase of refrigerated transport and controlled ripening. Individual chapters are devoted to the history of the banana industry, the structure, development and culture of the plant, the commercial storage and ripening of the fruit, with special reference to the related physiological and biochemical problems, the commercial utilization of banana products, their nutritive value, the diseases and pests that beset the crop, and statistics of the industry in different parts of the world. To cover this ground the author has had to refer to a wide range of literature, some of a rather general nature, but much of it, for example, the physiology and biochemistry of ripening fruit, of a highly specialized kind. In the chapter on the physiology of ripening fruits, a large volume of research results has been brought together for the first time.

Although it is possible to point to some omissions in the text, this work undoubtedly provides a valuable, condensed survey of information on the banana and should accordingly serve the purpose for which it is intended, that is, to enable research workers to become cognizant of what has already been achieved in this varied and interesting field.

C. W. WARDLAW

THEORY OF CRYSTAL GROWTH

By Prof. N. F. MOTT, F.R.S.

LAST April the Faraday Society held a Conference on crystal growth[1], and as a consequence of the interest aroused the Physics Department of the University of Bristol arranged a Summer School, held during September 19–24, 1949, in order to explain both the older theories of this subject and some recent advances which have been made in the past year. During the Summer School evidence hitherto unknown to the organisers was produced, which gave a quite dramatic proof of the correctness of some of the theories put forward; and it is with this evidence and these theories that the present article is concerned.

The subject to be discussed is the growth of a crystal face from the vapour or in solution, under conditions where the degree of supersaturation is small and nearly constant over the face. Dendrite formation will not be treated in detail, but a few words are necessary to dispose of it first. Dendrites grow in solution because a corner or protuberance sticks out into a region where the concentration of solute is higher than at other points on the surface, since it is less exhausted by the process of crystal formation; if growth at any point depends only on the local crystallographic orientation and the degree of supersaturation, these corners will grow faster than other points on the surface and form longer protuberances or dendrites, of which the ends will grow faster than ever as they protrude farther. If a crystal grows in a regular form, without dendrites sprouting from the corners, it shows that supersaturation cannot be the only controlling factor.

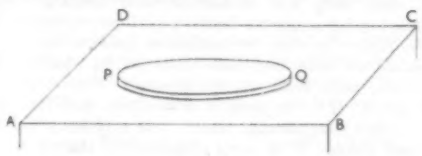


Fig. 1

Gibbs[2] was the first, and Volmer[3] the next to suggest a theory to account for the steady growth of a flat crystal face, even under conditions where the degree of supersaturation is not constant along the surface. This theory was developed in quantitative form by Stranski and Kaischew[4] and by Becker and Döring[5]. According to these authors, the factor which limits the rate of growth of a crystal face such as *ABCD* in Fig. 1 is the difficulty in forming two-dimensional nuclei such as *PQ*. *PQ* is a layer of molecules, one molecule thick and perhaps a hundred across, which is difficult to form, because any smaller-sized group is unstable. Once formed, however, such a layer spreads rapidly across the whole surface, and the process of growth is held up until a new nucleus forms. The chance per unit time that a nucleus is formed at any point depends on the degree of supersaturation there; but the mechanism ensures that the rate of growth of the whole surface is uniform.

An elementary estimate of the rate of nucleation can be made as follows. Assuming the nucleus to be circular and of radius r, its energy will be $-\pi r^2\omega + 2\pi r\sigma$, where ω is the free energy per unit area gained when molecules condense from the vapour on the surface, and σ is the energy per unit length of the steps at the boundaries of the ledge. This has a maximum value $\pi\sigma^2/\omega$ when $r = \sigma/\omega$, and the assumption is then made that the chance per unit time and per unit area that a nucleus is formed is

$$n \exp(-\pi\sigma^2/\omega kT),$$

where n is the number of molecules of the vapour (or solute) hitting unit area per unit time. Elementary considerations show that

$$\omega = kT\ (\ln \alpha)/a^2,$$

where a^2 is the area on the surface occupied by one atom and α is the degree of supersaturation, defined by $\alpha = p/p_0$. Here p is the pressure of the vapour, p_0 the vapour pressure of the solid. The rate of growth thus becomes

$$n \exp\{-\pi a^2\sigma^2/(kT)^2 \ln \alpha\}. \qquad (1)$$

This formula, or formulæ of the same general type, has been deduced by Becker and Döring[5] by a kinetic method, in which the arrival of each individual atom on to the nucleus is considered, and the chance that a large nucleus is formed calculated. Recently at Bristol the theoretical basis of this work has been re-examined in great detail by Burton and Cabrera[1] with special attention to the implicit assumption that the equilibrium surface of a crystal is very nearly a close-packed plane of molecules, and with a more detailed consideration of the shape of the nucleus in various stages of its growth and of the influence of molecular diffusion on the surface of the crystal. It is concluded that, apart from unimportant numerical factors, formula (1) is a correct deduction from the assumptions made.

Formula (1), however, is by no means in agreement with experiment. σa is of the order of the latent heat of vaporization; the insertion of numerical values shows that observable growth-rates will be obtained only if $\ln \alpha$ is at least of the order unity. The experiments of Volmer and Schultze[6] on the growth of crystals of iodine, naphthalene and white phosphorus from their vapours near 0° C. show that the growth-rate is not much less than the rate of incidence of molecules from the vapour and is proportional to the supersaturation, $\alpha - 1$, down to the lowest attainable values, except in the case of iodine when $\alpha - 1$ is less than 0·02. In this case the growth-rate does fall below the linear law and appears to vary as a higher power, perhaps as $(\alpha - 1)^2$, for these very low values of $(\alpha - 1)$.

An explanation of this discrepancy was first given by F. C. Frank[7], and in a paper presented to the Faraday Society Conference. This explanation is based on the theory of dislocations. A dislocation is a line discontinuity of a type which is believed to exist in any plastically curved crystal or any crystal with a mosaic structure; mosaic boundaries can, in fact, be described geometrically as rows of dislocations. There are two important types of dislocation, edge and screw; Frank points out that if a screw dislocation ends on a crystal face, that face has a ledge on it which extends from the point where the dislocation ends to the boundary of the face. This ledge remains, of course, if the surface is covered with one, two, three or any number of layers of atoms; and the face can grow by the rotation of the ledge about the end of the dislocation, without any necessity for the

formation of a nucleus. A face on which a screw dislocation ends can thus grow for low degrees of supersaturation; Frank concludes that under these conditions growth is possible only for crystals containing dislocations, and explains in this way the fact that this type of discontinuity, or in other words a mosaic structure, appears in general to exist in crystals investigated. A face with a screw dislocation ending on it is shown in Fig. 2.

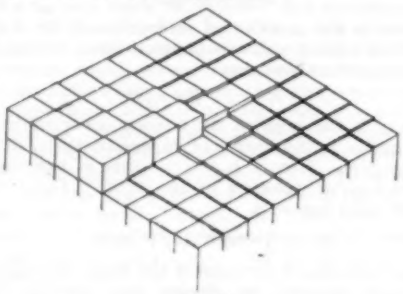


Fig. 2*

In the paper quoted, Frank then discusses in detail the form that the ledge will take during growth of the crystal. It will, of course, rotate round the point where the screw dislocation ends, but since each point on a straight ledge will, for a given degree of supersaturation, advance with the same speed, the ledge will soon curl up and form a spiral (Fig. 3). In order to calculate the shape of this spiral it is necessary to know how fast the ledge will advance. A rather difficult calculation[8] shows that a straight ledge will advance with velocity v_0 proportional to $\ln \alpha$, and that a curved ledge of radius of curvature r will advance with a speed

$$v_0 \left(1 - \frac{r}{r_0}\right). \qquad (2)$$

Here r_0 is evidently the size of the smallest nucleus that tends to grow rather than shrink, that for which the free energy is a maximum. Its value is given by

$$r_0 = \sigma a^3 / kT \ln \alpha.$$

Using this result, one finds that when the ledge of Fig. 2 has made several rotations it will settle down into the form of a spiral (Fig. 3*a*), in which the distance between the arms is of order r_0. The rate of growth of the surface is thus of order $v_0 a / r_0$, and therefore proportional to $(\ln \alpha)^2$—a prediction which seems qualitatively in accord with the results of Volmer and Schultze, that for low values of $\ln \alpha$ (that is, of $\alpha - 1$) the rate of growth increases with $\ln \alpha$ at a greater rate than the linear law.

It should be remarked that formula (2), and hence the variation with $(\ln \alpha)^2$, depend on the assumption that each molecule which lands on the surface comes off again, on the average, before moving through a distance r_0. At high values of the supersaturation, $(\ln \alpha)$, r_0 is small and this will no longer be the case. Under these conditions every molecule which reaches the surface will also reach the ledge, and the rate of growth will become proportional to $\ln \alpha$. When this is so, no quantitative account has been given of the central form of the spiral, but the principal results remain valid.

In the account of the Faraday Society Conference, Frank also gives a sketch of the ledges to be expected

* Figs. 2 and 3 are reproduced by permission from the Faraday Society's discussion on crystal growth.

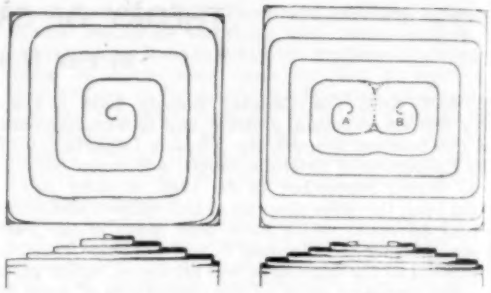


Fig. 3*a* Fig. 3*b*

in a crystal face on which two screw dislocations terminate, of right- and left-handed sign. These are shown in Fig. 3*b*. The ledge, starting on the end of one dislocation A, terminates on B; but as the spiral unfolds, its two arms will join together generating a closed loop.

This, then, was the form of the theory as it was presented to the Summer School at Bristol. The unexpected experimental evidence in its favour was provided by Mr. J. Griffin, of the Physics Department of the Royal Holloway College, University of London. Mr. Griffin has obtained photographs of the surface of a natural beryl crystal taken with a metallographic microscope, either directly on a crystal surface, or after a light deposition of silver. These photographs show line markings which in general followed contour lines of the crystal surface. There seems to be no reason to doubt that these are the edges of growth-layers; but the rather astonishing further conclusion presents itself as extremely probable, that they are monomolecular growth layers. Calibration by multiple-beam interference fringes has shown that the step in height at such a line is, by an unknown amount, less than 34 A., that is, less than four unit cells of the crystal. One would be hard put to it to explain a consistent unit height of step of this magnitude, which was anything but one unit cell thick. It is very remarkable that a feature of this height (7·9 A.) should be visible in the microscope; but there appears to be no theoretical reason why it should not, and the lines in any event take precisely the form expected for the edges of monomolecular growth terraces. Above all, whereas for the most part they do follow contour lines of the

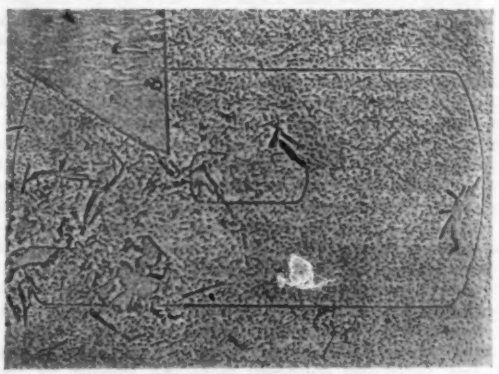


Fig. 4. Prism surface of beryl (× 525)

surface, there are particular regions of the crystal face where they terminate in just the manner the edge of a growth-terrace is expected to terminate at a dislocation. Some of the photographs obtained by Griffin correspond exactly to the simple cases of Figs. 3*a* and 3*b* above, Fig. 4 being an example; as well as many more complex examples in full agreement with theoretical expectation.

[1] Discussions of the Faraday Society, "Crystal Growth", 5 (1949).
[2] Gibbs, J. W., "Collected Works" (1878), 1 (Longmans, Green and Co., 1928), footnote on p. 325.
[3] Volmer, M., *Physik. Z.*, **22**, 646 (1921).
[4] Stranski, I. N., and Kaischew, R., *Physik. Z.*, **36**, 393 (1935).
[5] Becker, R., and Döring, W., *Ann. Physik*, **24**, 719 (1935).
[6] Volmer, M., and Schultze, W., *Z. phys. Chem.*, A, **156**, 1 (1931).
[7] Burton, W. K., Cabrera, N., and Frank, F. C., *Nature*, **163**, 398 (1949).
[8] Burton, W. K., Cabrera, N., and Frank, F. C. (to be published).

DOES WILD TEA EXIST?

By F. KINGDON-WARD

SOONER or later anyone interested in the tea plant (*Camellia sinensis*)—its origin, its great variation, and its geographical distribution—comes up against two difficult questions: (1) Does the wild tea plant exist anywhere? If so, where? (2) If not, where and how did the cultivated tea plant of to-day originate?

Our earliest knowledge of the tea plant is necessarily derived from China, where tea drinking dates back some 2,000 or 3,000 years. Whether or not the wild prototype does, or did, grow there, tea was cultivated in south-east China long before it was known to be cultivated anywhere else; and the habit of drinking tea was already prevalent and nearly a thousand years old before it was exported to the West.

But though the Chinese can claim the discovery of tea *drinking* (and, according to Bretschneider, quoted by Watt, used the leaf as a medicine long before that), nothing has been said about the origin of the tea bush itself.

To quote Watt again: "Several writers report having met with the Tea plant in a wild condition in certain parts of China and Cochin China. It was discovered wild, or at all events completely acclimatised, in various parts of Assam, by Bruce. . . ." Evidently Watt did not believe implicitly that wild tea grew in Assam; so he left the way open for a graceful retreat should it prove otherwise. Perhaps he was influenced by Griffith's opinion that the plant found in the Nasareh district of Assam by the early explorers was not the tea plant—meaning thereby, not the Chinese tea plant, which he knew—a conclusion with which most modern botanists would agree. There is a certain ingenuousness in Watt's choice of words—note "the Tea plant in a wild condition" not 'wild tea', and the alternative, "at all events completely acclimatised".

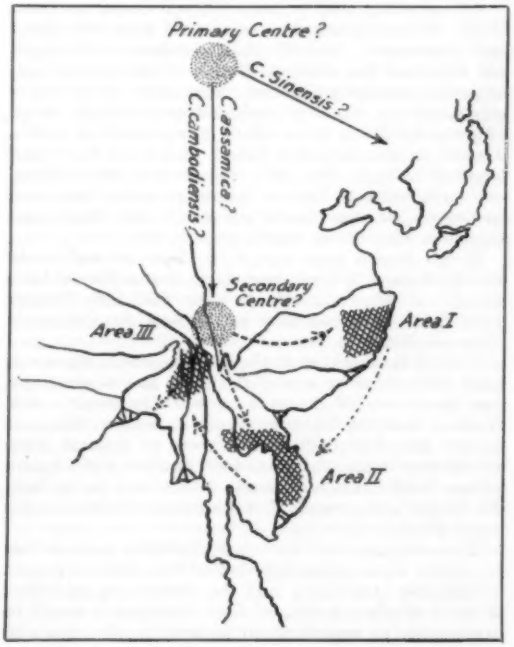
No such doubt is implied, however, when Watt records *his own* discovery of wild tea in Manipur in 1882, although there was rather less likelihood of its occurring wild in Manipur than in the Assam Valley. Actually, the Manipur wild tea is definitely not wild; it can only have been introduced from Burma, probably several centuries ago.

If wild tea exists, it must be rather rare. Many species of plants turn up again and again in herbarium collections; but not tea. One does not find many specimens of *Camellia sinensis* in plant collections from India, Burma, China, Malaya, Siam, or elsewhere. When it does occur, it is expressly stated to be the cultivated plant.

However, the fact that wild tea has not yet been found is no argument against its existence, when one considers the enormous area of unexplored highlands where it might survive. But if we found it, should we recognize it for tea? Not necessarily, surely, as the following considerations will make clear.

Let us first look at the many known varieties of the tea plant of commerce. Dr. W. Wight points out that there are three main races of tea, namely, China type, Assam type and Cambodia type. Further, he suggests that there are two main axes of geographical distribution, which run approximately east to west, and north to south (this last, more exactly, north-west to south-east), crossing at a point where Indo-Burma, Tibet and China meet—about lat. 29° N., long. 98° E. These two axes correspond roughly with the river valleys from the Brahmaputra to the Yangtze, between which lie the southward flowing Irrawaddy, Salween and Mekong, and the south-eastward flowing Red and West Rivers. Note that these valleys radiate out over nearly 180° of arc, like the spokes of a wheel.

It will be immediately remarked that the three extreme races of tea lie on the outer rim of this fan-shaped area, down which roll the great rivers of South-East Asia, and up which man would be likely to move. This will be made clearer if instead of two intersecting axes we recognize three principal routes of dispersal radiating from a centre somewhere near the sources of the Irrawaddy, each route ending with one of the three races concentrated in a terminal area. It would seem that the distribution of the tea plant in one form or another, 'wild' or cultivated, is more or less continuous along these three radii, the terminal areas of which are primarily occupied by (1) China type, (2) Cambodia type, (3) Assam type.



But while the extreme races are thus dispersed at wide intervals on a great arc reaching from the mouth of the Yangtze to the mouth of the Ganges, they do not occur singly at those extremities. In south-east China, for example, there is found not only the China type, but also the Assam type; in Indo-China certainly the Cambodia type and the Assam type, and very possibly the China type also; in Assam-Burma both the Assam type and the Cambodia type. (The influence of this last was long ago recognized by Dr. Wight, and more recently again in specimens of 'wild' tea collected by me in Manipur in 1948.)

It is worth recording that the peculiar type of *C. sinensis* which, according to Watt, has never been found wild, is "more abundantly represented in herbaria as coming from India than from China". It is the plant which everybody acclaims as tea, and is markedly different from all other races.

Some years ago Dr. Wight observed that Assam 'wild' tea always occurred close to one or other of the great highways of the Ahom kingdom, such as the Char Ali and Dhodar Ali—never in climax forest. It was invariably found in small patches, not dispersedly, in ground which might well have been formerly cultivated; just as it is found to-day, close to present or past village sites. Almost all later discoveries of 'wild' tea in Assam (as near Jaintiapur and in East Manipur by me) tend to confirm the correctness of this observation, which was accepted by the Dutch botanist Wellensieck when he visited Assam in 1937 and was shown some of the original 'wild' tea.

The occurrence of wild tea in Indo-China has long been known. Pierre recognized five varieties, and Eberhardt says that wild tea occurs along the whole length of the Annamite Chain from the extreme north of Tonkin to Cochin-China, and also in Laos. Thus, in fact, it occurs over the whole peninsula, as well as in Siam.

Of tea called wild in south-eastern China we know little. It has already been remarked that wild China tea is unknown; but the plant is cultivated throughout the black tea district. Forms of the Assam type, however, are also cultivated; and since all reports of cultivated tea, whether in plantation or village, speak of great variation, from which it is possible to isolate distinct strains, it seems certain that most cultivated teas are hybrid. The only exception is pure 'China'—if such exists! This is the more intelligible when we remember that tea is self-sterile, and that more than one race of tea exists in each area.

If the Assam type occurs in China as well as in Burma-Assam, it is not surprising that it should have found its way southwards into the Indo-Chinese peninsula. It is less easy to see how the Cambodia type reached Manipur.

Thus it is clear that in the three terminal tea areas, each dominated by one of the three major races, not less than two of those races actually occur; and further, that tea under cultivation, even in China, is a very variable plant—much more so than in some of the newer planted areas such as Java and Ceylon, where 'wild' tea is not found. If one may judge from Dr. Wight's experience in Assam, this variation is due to crossing.

The complex now known as *Camellia sinensis* has in earlier times been regarded as two distinct genera—*Camellia* and *Thea*; and the three main races are, in their extreme forms, so dissimilar that it would be reasonable to regard them as species, the more so since another plant, derived from an uncertain source in northern Burma, which has many of the characters of tea and crosses easily with it, cannot be assigned to any of the three major races, and must be regarded as a different species.

Clearly, then, the prototype of these three races, if they had a common origin, may have been something different again, and not at first sight obviously tea. For there is no evidence that they have been derived from one another. On the other hand, a plant like *Camellia taliensis* might equally be regarded as tea.

This brings us to the question: If wild tea does exist, what manner of plant is it? Is it a dwarf leathery-leafed bush like the China type, a small fastigiate tree with large leaves like many forms of the Assam type, or a small tree with moderate-sized leaves turning red in autumn like the Cambodia type? Or does it resemble none of these closely?

In attempting to discover a wild ancestor of the tea plant of commerce, three possible lines of research suggest themselves: (1) the historical approach, including archæology; (2) a knowledge of the distribution of all the species of *Camellia*, which might help us to arrive at a centre of diversity and indicate the probable direction of migration; (3) an investigation of all the varieties of *C. sinensis*, with the view of discovering where is the chief 'centre of diversity'. Let us examine these in turn for evidence.

(1) The history of tea, so far as it is known, has been told so often that it is unnecessary to repeat it here. The best account is probably that given by Watt[1]. The most ancient records deal with tea drinking (or with medicinal use) rather than with the plant itself and its origin; and there can be little doubt but that it is one of the more ancient cultivated plants, which may well go back to prehistoric times. But prehistory has thrown no light on the problem, nor would one expect it to do so, in a climate such as that favourable for the growth of tea. There is no evidence that tea had penetrated even so far west as the Indus civilization in prehistoric times. (Naturally the plant itself could not spread to the dry civilizations.)

Thus the early history of tea, and how knowledge of its use was spread, must be inferred from other sources, indirectly; perhaps not least from considerations of geography, and the migrations of peoples in South-East Asia. But it would help if we knew where it originated.

(2) The genus *Camellia* is restricted to the highlands of South-East Asia, from Japan to the eastern Himalayas as far west as Nepal. The most widespread species, if we accept all the reports of wild tea as wild, is *Camellia sinensis*, and the most widespread race of *C. sinensis* appears to be the Assam type.

Excluding tea in all its forms, some fifteen or twenty species of *Camellia* have been described—or at least named. Of the undoubted species, at least four are found in Assam (mainly south of the Brahmaputra), three on the Burma–Yunnan frontier farther east, and at least three in south-western Yunnan. That is to say, at least half the known species, and possibly two-thirds, come from the Assam–Burma–West China area, which is characterized (though not exclusively) by the Assam race of *Camellia sinensis*. This area, then, which I have called No. 3, would seem to be the centre of concentration, and the centre of diversity, using the term in the same sense in which it is used by Vavilov.

(3) Some indication of the races and varieties of *Camellia sinensis* has already been given. When we look for a centre of diversity for cultivated tea, we are met by the difficulty that so comparatively restricted is its range, and so continuous its distribution (as compared, for example, with wheat and rice), that any centre of diversity almost coincides with the total range, at least on the evidence at present available, and would have to include Indo-China (area No. 2) and the eastern China region (area No. 1). Plants which occur in Japan or Formosa, and, skipping two thousand miles, crop up again in the eastern Himalaya (they are not a few) can scarcely have acquired that peculiarly interrupted distribution except on the supposition that they were dispersed from a restricted area and fled southwards, however slowly and sedately, along radial or longitudinal communication lines, either valleys or mountain ranges. The common centre from which they set out may have been as far north as the 60th parallel, or even within the Arctic Circle. It may, on the other hand, have been farther south, in the Altai or some part of the Mongolian plateau.

Obviously, we do not know whether the strongly marked races of tea reached the terminal areas as races (or species), or whether they evolved from a single uniform race *in situ*. The most divergent race, at least in appearance, is the China type—the only one that nobody has claimed to have found growing wild. The Assam and Cambodia races are far less unlike in appearance—apart from the amount of anthocyanin present in the latter.

That the Assam and Cambodia races may have had a common origin where the divergent threads of the great rivers are gathered together is suggested by the discovery of a *Camellia* in the Mishmi Hills in the north-east corner of Assam, in 1949. This plant (*K.W.* 18530), of which the specimens* comprise foliage only, was found growing completely wild in the hill jungle, and is undoubtedly tea—*Camellia sinensis*. Judging by the leaf, it is of the Assam race; but without either flowers or fruit, it would be rash to say more.

Yet it is difficult to believe that the China race, so different in habit and appearance, has not had a separate origin, especially when we find that the teas grown in western China, both in the north (Yachow district of Szechuan) and in the south (Puerh district of Yunnan), are of the Assam race, which, in fact, through the hilly country of south China, reaches eastwards to the coastal tea districts.

It seems possible, then, that the China race came from the north around the Pacific seaboard, as other elements of the flora did, during the glacial shake-out; while the Assam race took the more direct route from Central Asia. If this view is correct, the China type has had one origin and the Assam and Cambodia races another, further implying that the Irrawaddy region is a secondary centre of dispersal, and that we must look much nearer to Central Asia for the primary centre. We are unlikely to find any but indirect evidence for the truth of this.

During the long, if limited, glaciation of northern Asia, the primary centre of dispersal would have been operative, as in Europe and America. Thus, we find a correspondence between the floras of Japan and of the eastern Himalaya. The dispersal of species from the secondary centre is more recent. The eastern Himalaya show clear signs of intense glaciation, with glaciers descending almost to the plains of Assam and northern Burma, which even the heavy rains of this region have been unable to wipe out. In the Mishmi Hills, and even so far south as East Manipur, I have found unmistakable, if fainter, evidence of glaciation; and it seems probable that within the last ten thousand years or less the climate has become more genial, allowing a considerable resettlement of the refugee flora, which has found its way northwards again up the warm damp valleys.

Yet, apart from the dispersal of the genus *Camellia*, the dispersal of the races of tea in South-East Asia is no simple matter. It is worth noting the almost invariable association of tea with the Thai (Shan) people. In the Upper Yangtze Valley (whence the Thai may have sprung), in south-east China and southwards to Laos and Siam, westwards to Yunnan, Burma and Assam, to every region where the Thai have gone, now as conquerors, now as refugees, the village cultivation of tea has been a cottage industry, and wild tea has been reported.

It is therefore tempting to identify the dispersal of tea with the historical records of Thai migrations. Unfortunately, though the Thai no doubt first reached south-east China from the direction of Central Asia, their later movements were westwards rather than eastwards, and southwards rather than northwards. It thus becomes difficult to correlate the early eastward spread of the Assam type with the Thai, though easy enough to account for any later movements of it (though not, apparently, of the China race) southwestwards. One can do no more for the present than await further evidence.

* In the herbarium of the New York Botanic Garden; and of Tocklai Tea Research Station, Assam.

[1] "The Commercial Products of India."

OBITUARIES

Dr. Leonor Michaelis

DR. LEONOR MICHAELIS, member emeritus of the Rockefeller Institute for Medical Research, died recently in his seventy-fifth year. Thus ended the career of one of the most prolific and original scientific minds of the twentieth century.

Dr. Michaelis was of those rare individuals possessed of a healthy body and endowed with the precious gifts of genius. He learned with ease, his memory was tenacious, he could quickly grasp the essence of a problem, he was a vigorous, persistent and meticulous worker. Aware of these blessings, he was a modest man.

Leonor Michaelis was born in Berlin in 1875 and entered the University of Berlin in 1893. In his early days he was an enthusiastic mountain climber, and also well-nigh a necromancer of the then newly developing silver bromide plate. In later years one of his absorbing devotions was to music; with little formal training, he was an accomplished pianist and composer. Once at a gathering of friends, in response to a request, he sat down at the piano and, on the theme of "Yankee Doodle", extemporized a sonata in perfect classical form, in four movements, ending with an elaborate and lively fugue. Another of his avocations was comparative linguistics and philology; and during his three-year visit to Japan he studied the Japanese and Chinese languages.

While a student at the University of Berlin, Michaelis assisted in the laboratory of Prof. Oskar Hertwig. His first paper, in 1897, was on the problem

of whether the point at which the sperm fertilizes the egg determines the first cleavage furrow. The answer was no, and recently he remarked, with a twinkle in his eye, that this finding still seemed valid. In the next year he published a paper on the histology of milk secretion, which was awarded a prize from the medical faculty. His gift for exposition and for a grasp of the particular field of his study was made evident in the writing at this time of a text-book on embryology for medical students, which in rapid succession went into some nine editions.

In Berlin his work came to the attention of Paul Ehrlich, who offered him a position as assistant. Here he studied the histological staining properties of the various new dyes then under elaboration by the German chemical dye industry; and while so doing he discovered the specific vital-staining effect of Janus Green on certain cytoplasmic bodies which were later to become known as mitochondria. In this new field of his endeavour he wrote a text-book on the chemistry of dyestuffs for histologists, a book which revealed a mature understanding of the basic chemical processes underlying the staining techniques.

For a few years after he worked on the transplantation of mouse cancer, and was among those who first found that the success of transplantation depends on the strain of the species used. He also observed a marked change in the immunological specificity of serum albumin when digested for an exceedingly short time with pepsin.

In 1905, Michaelis became bacteriologist in the municipal hospital in Berlin, and in close co-operation with Peter Rona undertook problems which were primarily in the newly developing field of physical chemistry. His main life's work was to be in this field, and in it he could use to the fullest his abilities to ask questions about living things and set up basic experiments involving few variables. His laboratory was on a most primitive and restricted scale. The City administration strongly discouraged any kind of research in municipal hospitals. Such work was frowned upon also by the director, who could not see how studies of such problems as hydrogen-ion concentration in relation to enzymic activity, fundamental studies on electrophoresis of proteins, a theory of enzyme affinity for substrate (Michaelis–Menten), studies on enzyme inhibitors, the problems of exchange adsorption of dyestuffs—how all these could be related to the cause and cure of disease. Only later were his studies realized to have provided integral parts of the framework of our knowledge of enzyme action and protein behaviour. In 1914 his book on hydrogen-ion concentration appeared, which was to become a classic in the field of physical chemistry. At this time also he wrote his stimulating book on "Dynamics of Surfaces", and his manual of physical chemistry. For the purpose of his investigations he found it necessary to learn more mathematics, and he summarized his studies on this theme in another fine book, "Mathematics for Biologists and Chemists", published in 1921.

In 1922 he was invited as visiting professor in biochemistry to the Medical School of Nagoya, Japan. This was an unusual event, since no foreigner had been engaged as full professor in Japan for a long time. He remained there for three years, was greatly honoured, had many graduate students, and was provided with excellent facilities for research. Here he began studies on permeability with artificial membranes specifically permeable to positive ions. Of the permeability of the living membranes he once remarked, "We know what it can be, what it might be, and still it is different".

In 1926 he went to Johns Hopkins University as a resident lecturer, and three years later was appointed a member of the Rockefeller Institute for Medical Research. The field of his main achievements in the United States centred around problems of oxidation and reduction. He was not only interested in investigating these problems, using the customary formal thermodynamic approach, but also at the same time inquired into the specific mechanisms by which these oxidations could take place. Early in this work he developed an ingenious theory of heavy metal ion catalysis, based on the formation of Werner complexes, to explain the effect of iron in catalysing cysteine oxidation with oxygen. This study was soon followed by the fundamental discovery of organic radicals stable in aqueous solutions, the 'semiquinones', a discovery arising from inquiries into the anomalous behaviour of certain compounds during potentiometric titration. The idea of the existence of organic radicals in aqueous solution met with considerable opposition, so much so that his first papers on the subject had to be published in European journals. A firm and independent proof of the existence of these semiquinones, or radicals containing unpaired electrons, was provided by magneto-chemical experiments. Different organic compounds provided further examples of these radicals, the stability of which is most readily accounted for on the principle of resonance. Some of these observations are summarized in his book on oxidation-reduction potentials, which has been translated into a number of languages. The beautifully developed thermodynamic equations of semiquinone formation were used in one paper to obtain values of acidity in strongly acid solution. The dimerization of the organic radicals led him to investigate the dimerization of dyes and other molecules, and to renewed studies of the metachromatic effect of dyes in histological staining, a problem which had intrigued him in his early years with Ehrlich. Further magneto-chemical investigations included the studies on ferritin iron, on ferric phenanthrolene, on the reversible oxygenated complexes of cobaltiac and of cobalt histidine.

Among other subjects he investigated was the conversion, using thioglycollate, of keratin into soluble material. The principle of this study is to-day the basis of the 'cold permanent wave' industry of cosmeticians. His most recent feat was the discovery of the radical of vitamin E, a discovery which may prove to be basic to an understanding of the action of this vitamin.

Dr. Michaelis is survived by his wife, Hedwig Philipsthal, and his two daughters, Ilse Wolman and Eva M. Jacoby.

By those who knew him closely and worked with him, Dr. Michaelis was respected and honoured. By his contemporaries his abilities were envied and admired. His influence on the world of science will be lasting.

S. GRANICK

WE regret to announce the following deaths:

Mr. A. J. Wilmott, deputy keeper in the Department of Botany, British Museum (Natural History), on January 27, aged sixty-one.

Prof. W. P. Wynne, F.R.S., emeritus professor of chemistry in the University of Sheffield, on February 16, aged eighty-nine.

NEWS and VIEWS

A Big Sunspot

A BIG group of spots, brought into view by the sun's rotation on February 14, has crossed the sun's disk and will pass out of sight on February 27. In northern latitude 11°, the centre of this complex group crossed the central meridian on February 20.2 U.T. At the time of this notification (February 18), the area covered by the spots was nearly 3,000 millionths of the sun's hemisphere, or about seventy times the cross-section area of the earth. This group will probably not have been exceeded in size since 1947 (the peak year of the present eleven-year sunspot cycle), when the outstanding group had an area nearly double that of the present one. Judging from size alone, the present group is quite likely to be associated with geomagnetic and ionospheric disturbance, the most likely times being February 18–24.

Planets and Sunspots

K. G. MELDAHL, who has produced some previous works on tidal forces in the sun's corona due to planets, Part 1 in an English edition in 1938 (see *Nature*, **144**, 726; 1939), has now published Part 2 (Berlinste Forlag, Copenhagen). This consists mainly of six figures showing the relative magnitude, heliocentric direction, continual recurrence, and the period of 308·52 years of the tidal force, printed on a single roll. The calculations cover 498 years—from 1663 to 2160—and the close agreements between the regions of the years 1843 and 2152, shown in Fig. 2, confirm this period of 308·52 years. It is shown that there are a period of about 0·97 year and another of about 5·56 years, or multiples of both (the latter being half the average sunspot period), permeating the whole of the field. The same planets are dealt with as on previous occasions, namely, Mercury, Venus, Earth, Jupiter and Saturn; and it is claimed that the connexion between the tidal period and the observed average sunspot periods has been established by the ever-recurring and interacting periods of 5·56, 11·12, etc., years. It is hoped that careful observations will be carried out on the interaction between the auroras and tidal forces and their directions; Figs. 3 and 4 show this and explain the prediction in 1937 for the great auroras in 1938, afterwards verified, and also for somewhat similar conditions during January and February 1950. While this note was in course of preparation, there has been a remarkable fulfilment of these last predictions. Exceptional auroras observed in Denmark were responsible for some alarm among the fire brigades, which took them at first for large fires. In addition, Dr. Meldahl has been observing auroras in Fredrikstad, Norway, from the middle of January until the middle of February, and from all the evidence it seems that his theory deserves much more consideration than it has previously received.

Atomic Physics at the Science Museum, London

A MODEL of the first atomic pile at Harwell, the Graphite Low-Energy Experimental Pile (G.L.E.E.P.), has been lent to the Science Museum, South Kensington, London, S.W.7, by the Ministry of Supply and is now on exhibition on the second floor of the Museum. This pile went into operation in August 1947 and has been used for making radioactive isotopes, for measuring the properties of atomic nuclei, and for testing the nuclear properties of materials used in pile construction. Among neighbouring exhibits at the Science Museum are other pieces of apparatus which have played a notable part in the development of atomic physics, including Aston's original mass-spectrograph of 1919 with which atomic masses were first accurately compared, and part of Cockcroft and Walton's original apparatus with which artificial nuclear disintegration by purely electrical means was first achieved in 1932.

In a recently re-opened gallery on the top floor of the Museum further exhibits relating to modern physics may be seen. Several models illustrate the structure of atoms and molecules, while another, larger group of exhibits shows the development of electron physics. Included among them are many working models and illuminated diagrams to demonstrate principle; one shows the various controls of a cathode-ray tube and their function; another demonstrates the response of photocells of different types to variations in the intensity and colour of the light falling upon them. Historical development is covered by the exhibition of original apparatus in the usual sequence; there are also exhibits, which can be worked by the visitor, designed to show the principles of historic experiments such as those of J. J. Thomson which led to the discovery of the electron.

Ciphering of Organic Structural Formulæ

THE Commission on Codification, Ciphering, and Punched Card Techniques, set up by the International Union of Pure and Applied Chemistry, has issued a list of attributes to be considered in judging systems for ciphering organic structural formulæ, and invites all persons who may have developed ciphering systems to submit them to the Commission. The following points should be considered: (1) simplicity of usage; (2) ease of printing and typewriting; (3) conciseness; (4) recognizability; (5) ability to generate a unique organic chemical nomenclature; (6) compatibility with accepted practices of inorganic chemical notation; (7) generation of an unambiguous and useful enumeration pattern; (8) ease of manipulation by machine methods, for example, punched cards; (9) exhibition of association (descriptiveness); (10) ability to deal with partial indeterminants. Those submitting ciphering systems will be given an opportunity of proposing additions to the above points. Detailed descriptions of new systems should be sent before March 1, 1950, to the acting secretary of the Commission, J. W. Perry, Room 20-E-215, Massachusetts Institute of Technology, Cambridge 39, Mass. In order to ensure that nothing is overlooked in subsequent testing, those submitting systems will be asked to demonstrate the application of their systems by a list of compounds compiled by taking the first four entries on every hundredth page of Beilstein. At present four systems, none of them in completely developed form, have come to the attention of the Commission.

British Institute of Management

IN his chairman's address to the British Institute of Management at its second annual general meeting, Sir Charles Renold stated that although the Institute only opened its doors in a temporary office on September 1, 1947, good progress has been made in selecting staff and finding accommodation, in spite of unexpected difficulties. Arrangements have been completed for a seven-year lease of a block of buildings on the other side of Hill Street,

London, W.1, from its present premises, and the staff now numbers 118, mainly engaged on clerical and secretarial duties. The Information and Research Department comprises four divisions, concerned with finance and office management, personnel management, marketing and sales management, and production management, and includes the reference library. As regards finance, Sir Charles estimated that the Institute would at the earliest possible date require an annual income of not less than £100,000 in order to free itself from government financial assistance. It is hoped by 1952 to secure a fully representative council in which all the originally nominated members would be replaced, unless re-elected individually for a further term, and that it would soon be possible for the council to reach decisions on the fundamental principles involved in implementing the recommendation of the Baillieu Report with regard to the establishment of the Institute as a professional body with defined grades of membership. The Institute has already taken over the functions of the British Management Council, and the agreement with the Institute of Industrial Administration is designed to lead to a complete merger at the end of three years. Good progress is being made in building up a comprehensive information service, and the education committee is reviewing the whole field of education for management. Discussions have already taken place with university authorities on the contribution which the universities could make in this field.

Journal of the Science of Food and Agriculture

THE Society of Chemical Industry published in January the first number of a new monthly, the *Journal of the Science of Food and Agriculture* (1, No. 1; 1950. 3*s*., or 30*s*. per year; to members, 8*s*.). This new publication relieves the Society from the difficulty of finding room in the *Journal of the Society of Chemical Industry* for the increasing number of papers on food and agriculture which have been competing for space. Messages of goodwill from the respective Government Ministers indicate the importance that is attached to these two fields of activity, and this receives further emphasis in an article by Viscount Bruce on the work of the United Nations Food and Agriculture Organisation. It is perhaps significant of the present trend of food research in Great Britain that out of the seven research papers published in this number, three deal with fruits, one with vegetables, one with cereals, and only two with animal products. Vitamin C figures in two papers: one from the Royal Forest Factory at Coleford gives an interesting account of ascorbic acid oxidase inhibitors in black currants, and the other from the Lyons Laboratories, London, and the Western Province Fruit Research Station, Department of Agriculture, Union of South Africa, compares the vitamin-C content of English and South African cabbages. Two papers, from the Lyons Laboratories and from the Defence Research Laboratories, General Chemistry Section, Maribyrnong, Victoria, provide valuable analytical data on fruits and on elephant-seal oil respectively. Three papers deal with general biochemical problems: prevention of staling in bread (Government Laboratory, London); the combination of sulphur dioxide with concentrated orange juice (Low Temperature Research Station, Cambridge); and the oxidation of fat in dehydrated herrings (Torry Research Station, Aberdeen). Readers will look forward to further numbers, which will furnish a balanced picture of food and agricultural research being undertaken by academic and industrial workers in Great Britain as well as in other parts of the Commonwealth.

Industrial Postgraduate Course in Engineering

A LEAFLET recently issued by the British Thomson-Houston Co., Ltd., reprints an article from *BTH Activities* which describes the advanced engineering course instituted two years ago by the Company at the Rugby works. This is a course of advanced lectures in mathematical analysis applied to physical and engineering problems which is given to a group of graduate apprentices. The course comprises two lectures each week given in working hours, and associated with the lectures is an evening tutorial class of two hours duration. The general character of the course, which extends over two years, may be gauged from the following list of topics. *First-year course:* general revision; vector field theory; operational calculus; theory of elasticity. *Second-year course:* differential equations; complex variable theory; determinants, matrices and tensors; mathematical statistics; advanced dynamics. Normally some sixteen men are selected for the first-year course, and at the end of the first year a further selection of a smaller number is made from those who wish to proceed to the second year. The purpose of the course is to meet the need experienced by those engaged in advanced design and research for mathematical equipment beyond that provided by the undergraduate course at the university. The basic mathematical work occupies one of the weekly lectures, while the second lecture deals with a related practical problem. Each of the practical lectures is given by an engineer who is a specialist in the subject. This intimate contact of the course with actual engineering problems not only stimulates the interest of the students but also ensures its development to keep pace with advances in practice.

Brotherton Collection, University of Leeds

THE thirteenth annual report of the Brotherton Collection Committee covering the session 1947–48 (pp. 12; University of Leeds, 1949) gives the contents of the Collection on June 30, 1948, as 22,764 books, 15,615 pamphlets, 477 manuscripts, 4,105 deeds, 31,216 letters and 25 maps. Cataloguing of nineteenth-century English literature continued, and 1,558 slips were added to the catalogue. Work has been commenced on the compilation of a detailed list of notable people whose correspondence with Sir Edmund Gosse is preserved in the Collection. The first of three exhibitions in the main Brotherton Room traced the development of the art of book illustration from the fifteenth century to the work of modern illustrators, while a third exhibition traced the development of the art of printing from Gutenberg to the present day. An exhibition of more special interest covered recent publications of the North American university presses.

Work of the British–Kenya Miocene Expedition during 1949

THE work carried out in 1949 by the British–Kenya Miocene Expedition was financed by a grant from the Kenya Government and by funds made available by Mr. C. W. Boise for the purchase of a motor-boat to facilitate work on the islands in Lake Victoria. The activities during the season, which started in February, were completed at the end of November,

and resulted in the collection of 2,043 specimens of Miocene fossils. On the specimens, 134 represent the remains of primates (anthropoid apes, cercopithecoid monkeys and lemuroids). The remainder of the collection includes *Dinotherium*, rodents, shrews and fossilized fruits, seeds, etc. In August, a number of islands situated north and west of Rusinga were explored, but no Miocene exposures were found in them. In September, the fossil beds which had been reported by Prof. R. M. Shackleton in the Maralal–Rumuruti area were examined; but they proved disappointing, since the fossils in them were found to consist mainly of very fragmentary remains of fish, crocodile and tortoise. Excavations at Songhor led to further discoveries of isolated teeth of the large species of *Proconsul* (*P. major*), of which the type specimen was found in 1948.

Indian Heart Journal

Records of the progress of science and medicine in India continue to find publication, and the first issue of the *Indian Heart Journal* (pp. 100; 1949; Cardiological Society of India, 67 Dharamtala Street, Calcutta 13; 7.8 Rs. or 15s.) launches a new publication devoted to the study of the heart and circulation and allied subjects. This first issue contains six original articles, all by Indian authors, together with some abstracts of current literature and a book review. Well produced and convenient to handle, the journal will put cardiologists all over the world in touch with the work of their colleagues in India.

Foreign Scholarships for British Students

A number of foreign governments and universities are offering scholarships to British students for the year 1950–51, most of the scholarships providing for a year of postgraduate study in the foreign country concerned. Arrangements are made through the British Council. The countries which are continuing schemes already in operation are: Belgium, Czechoslovakia, Denmark, Finland, France, Germany (Universities of Cologne and Munster), Italy, the Netherlands, Norway, Persia (University of Teheran) and Sweden. In addition, three new scholarships, each valued at £640, are being offered by Brazil, and another is tenable at the University of Neuchatel, Switzerland. The closing date for applications is March 10, and the awards will probably be announced by the beginning of the normal university summer term. Details of these scholarships are contained in a booklet issued by the British Council and obtainable from the Controller, Education Division, British Council, 3 Hanover Street, London, W.1.

University of Birmingham

The following announcements have recently been made in the University of Birmingham: W. B. Watson has been appointed lecturer in mining; R. W. Stuart Mitchell has resigned his lectureship in mechanical engineering on being appointed chief research engineer, Diesel Engine Division, English Electric Co., Ltd.; the degree of doctor of science, in the subject indicated, has been conferred on R. S. W. Thorne (industrial fermentation) and H. B. Whittington (geology).

The Night Sky in March

Full moon occurs on March 4d. 10h. 34m., U.T., and new moon on March 18d. 15h. 20m. The following conjunctions with the moon take place: March 4d. 16h., Saturn 0·3° N.; March 6d. 06h., Mars 4° N.; March 14d. 18h., Venus 9° N.; March 15d. 20h., Jupiter 3° N.; March 31d. 23h., Saturn 0·1° N. In addition to these conjunctions with the moon, Mercury is in conjunction with Jupiter on March 1d. 15h., Mercury being 1·2° S. Mercury is too close to the sun for favourable observation and is in superior conjunction on March 28. Venus is a morning star, stellar magnitude −4·3, and rises about 1½ hours before the sun throughout the month. The visible portion of the illuminated disk increases from 0·2 to 0·4, and on March 6 the planet attains its greatest brilliancy. Mars, in the constellation of Virgo, rises at 20h. 10m. and 17h. 10m. at the beginning and end of the month respectively, and is in opposition on March 23. Jupiter, a morning star, is too close to the sun for favourable observation until the end of the month, when it rises about an hour before the sun. Saturn, in opposition on March 7, is visible throughout the night in the constellation of Leo. An annular eclipse of the sun on March 18 is invisible at Greenwich but can be seen over portions of the southern hemisphere. Occultations of stars brighter than magnitude 6 are as follows: March 7d. 03h. 00·9m., α Virg. (*D*); March 7d. 03h. 38·1m., α Virg. (*R*); March 23d. 20h. 30·2m., 23 Taur. (*D*); March 23d. 21h. 54·5m., 27 Taur. *m*, (*D*); March 26d. 23h. 40·6m., 49 Auri (*D*); March 28d. 19h. 20·3m., λ Canc. (*D*); March 31d. 21h. 22m., χ Leon. (*D*). *R* and *D* refer to reappearance and disappearance respectively, and the latitude of Greenwich is assumed. Vernal equinox is on March 21d. 05h.

Announcements

The Principal Trustees of the British Museum have appointed Prof. G. R. de Beer, professor of embryology at University College, London, to be director of the British Museum (Natural History) with effect from May 1, 1950, in succession to Mr. N. B. Kinnear, who is retiring.

The Institution of the Rubber Industry is organising a conference on "Rubber as an Engineering Material", to be held at the Overseas League (Headquarters), Park Place, St. James's, London, S.W.1, on March 17. Further details can be obtained from the Secretary, Institution of the Rubber Industry, 12 Whitehall, London, S.W.1.

The Royal Statistical Society has recently received an anonymous benefaction of £30,000 to enable it to acquire premises worthy of its history, traditions and scientific work as a learned society. It has outgrown its present premises at 4 Portugal Street, London, W.C.2, and for some years has been seeking a building in which its large and valuable library may be housed and in which its work can be adequately carried out. The growing recognition of the importance of statistics in government, business and science may be gauged by the increase in the number of fellows from a thousand in 1938 to more than two thousand at the present time.

The Congress of the International Society of Hæmatology will be held in Cambridge during August 21–26, 1950. Sessions will be devoted to discussions of anæmias, leukæmias, blood coagulation and immuno-hæmatology. Applications to attend the Congress should be sent at once to the Congress Secretary-Treasurer: Dr. Martin Hynes, Department of Medicine, University of Cambridge.

RETINAL OXYGEN SUPPLY AND MACULAR PIGMENTATION

IN their recent communication under the above title, Drs. Dartnall and Thomson[1] write that the presence of the yellow pigment in the fovea of the human eye will make it less efficient for vision; they suggest that the pigment is there to carry oxygen to those regions of the fovea which have no capillaries.

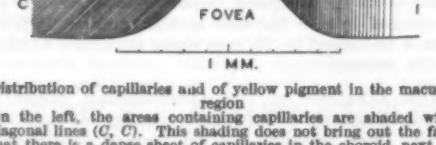
The presence of a pigment with a strong absorption in the blue may, however, be an advantage, rather than a disadvantage, from the point of view of visual acuity, because chromatic aberration becomes greatly disturbing at the short-wave end of the spectrum. Fick[2] as early as 1875 stated that it is the chromatic aberration which will set a natural short-wave limit to the human visible spectrum. It would therefore seem appropriate that the region of the highest acuity should be made less sensitive to short-wave radiation.

In blue or violet light the human 'emmetropic' eye is actually myopic, to the extent of about 1 dioptre[3,4]. Absorption of the blue and violet radiations on their way to the photo-receptors should therefore be beneficial for accurate focusing of the retinal image in ordinary daylight. It is true that objects which reflect blue or violet radiations will then tend to look darker than they would otherwise look; but this is not necessarily always a disadvantage. On the contrary, when they are seen against a bright background of another colour, this will increase the brightness contrast and improve acuity. Thus it is not unreasonable to suppose that the function of the yellow pigment of the macula may be to absorb these short-wave radiations in order to improve foveal acuity.

The suggestion that the yellow pigment may be concerned in the respiration of the tissues of the fovea receives little support from a consideration of its distribution, as shown in the accompanying diagram. First, according to Schultze[5] and Polyak[6], the pigment is only found in the inner layers of the retina, being absent from the outer layers which contain the photo-receptors. The respiration of these outer layers, which account for most of the retina's thickness in the capillary-free area of the fovea, must therefore be carried out without the aid of the pigment. Secondly, the major part of the yellow pigment is found in the foveal slopes[5,6] which have capillaries[7,8], and in which it should apparently not be needed for respiration.

In the extra-macular region, it is probable that respiration depends on oxygen supplied to the tissues by diffusion from the capillaries of the choroid and of the inner retinal layers. Referring to the geometrical conditions as shown in the diagram, one may wonder whether foveal tissues cannot be supplied in the same way. In view of the lack of information on the oxygen requirements of the various retinal layers and of the diffusion constant of oxygen through them, it is not possible to establish this point by quantitative calculations[9]. However, Wagenmann[10] showed that the outer layers depend mostly on the choriocapillaries for their nutrients. On this basis, if we take it that these layers receive a sufficient oxygen supply from the choriocapillaries alone, the supply should also be adequate for the whole of the fovea—since the capillary-free part of the fovea is little or no thicker than the outer retinal layers at the edge of the yellow spot.

In any event, while a pigment in the retinal tissues could store oxygen, it is not clear how it could increase the *rate* of supply of oxygen to them under the *steady-state* conditions which must generally prevail in daylight.



Distribution of capillaries and of yellow pigment in the macular region

On the left, the areas containing capillaries are shaded with diagonal lines (*C*, *C*). This shading does not bring out the fact that there is a dense sheet of capillaries in the choroid next to the outer retinal layers[11], while capillaries are more sparsely distributed in the inner layers[9,12]. On the right, vertical shading gives a rough indication of the pigment concentration. The outer retinal layers are denoted by *OO* and the inner layers by *I*. Dimensions and yellow pigment distribution after Schultze[5] (compare with Polyak[13]). Size of capillary-free area according to Weale[7]

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Nov. 25.

[1] Dartnall, H. J. A., and Thomson, L. C., *Nature*, **164**, 876 (1949).
[2] Fick, A., in Hermann's "Handbuch der Physiologie", **3**, Pt. 1, 182 (1879).
[3] Shlaer, S., Smith, E. L., and Chase, A. M., *J. Gen. Physiol.*, **25**, 553 (1942).
[4] Wald, G., and Griffin, R. D., *J. Opt. Soc. Amer.*, **37**, 321 (1947).
[5] Schultze, M., *Arch. mikr. Anat.*, **2**, 175 (1866).
[6] Polyak, S. J., "The Retina", 198 (Chicago, 1941).
[7] Weale, R. A., quoted by Dartnall and Thomson, ref. 1. In the latter paper, 1° 30′ is a misprint and should read 1 degree 30 minutes (personal communication from Dr. Dartnall).
[8] Polyak, ref. 6, p. 207.
[9] Hill, A. V., *Proc. Roy. Soc.*, B, **104**, 39 (1928–29).
[10] Wagenmann, *Arch. f. Ophth.*, **36** (4), 1 (1890), quoted in Duke-Elder, ref. 11, p. 481.
[11] Duke-Elder, Sir Stewart, "Textbook of Ophthalmology", **1**, 55 (1932).
[12] Duke-Elder, ref. 11, p. 142.
[13] Polyak, ref. 6, p. 447.

IN their letter in *Nature* of November 19, Dr. Dartnall and Dr. Thomson advance the view that the macular pigment plays the part of an oxidation-reduction system in the human macula and fovea. I do not feel that a satisfactory case has been made out for the existence of this pigment at the fovea; nor for the need for an auxiliary oxygen-carrying system.

(1) Dartnall and Thomson do not refer in their letter to the fact that the retina has a double blood supply: a superficial supply by means of the retinal vessels, and a deep supply by means of the choroidal vessels. The former consists of a coarse net of narrow bore blood vessels with few widely spaced capillaries. The latter consists of a dense feltwork of blood vessels which supply arches of capillaries so closely meshed that few parts of the adult human body present a similar picture. In consequence, these vessels provide the outer side of the retina with a blood supply of a richness probably not exceeded anywhere else. Thus the statement which Dartnall and Thomson make is true, namely, that there are no retinal vessels at the foveal centre. But the

inference they draw, that in consequence of this there should be a relative shortage of oxygen, is open to grave doubt unless it can be shown that the choroidal blood supply is either deficient, or absent, at this part of the retina. Such is not the case, however, because Wolff, in his "Anatomy of the Eye and Orbit", writes on p. 70: "The number of vessels in the macular region is much greater than elsewhere, so that here in a well injected specimen an almost inextricable mass of vessels of various sizes is seen". Thus an oxygen deficiency of the fovea is unlikely because of the generous compensatory blood supply provided by the choroid, and because of the thinness of the retina in this situation.

(2) According to Dartnall and Thomson, it would be expected that a shortage of oxygen would cause blindness at the fovea, but little effect at other parts of the retina, whereas, in fact, the opposite is found to be the case, and they suggest that this points to the presence in the fovea of a special biochemical system for the purpose of assisting oxidation by raising the oxygen tension. Three comments may be made on these suggestions: (*a*) that oxidation-reduction systems do not raise oxygen tension, but only enable the oxygen which is available to be employed with greater efficiency; (*b*) that such biochemical systems may help to deal with an oxygen shortage, but cannot assist either with the other shortages of substances needed for purposes of metabolism, or with the accumulation of waste products, which probably more than anything else adversely affect tissues which are suffering from a reduced blood supply; (*c*) that an alternative and more likely explanation is available as follows: the retinal sense cells, the rods and cones, are quite close to the choroidal capillary network, and are relatively a long way from the retinal capillaries. It seems likely, therefore, that the latter are more concerned with the nutrition of the nervous structures, which are close to them, particularly the ganglion cells and optic nerve fibres. Now light rays on their way to the receptor cell-layer have to pass partly in between the vessels, and partly through the walls of the vessels themselves. Therefore, in order to avoid an unnecessary loss of light, it seems likely that these vessels have been reduced as far as possible both in number and diameter, so that they provide for the metabolic needs of the nervous structures, but no more. Thus any interference with the blood flow through these vessels would be expected to affect the nutrition of the nervous structures. Now the nerve fibres which connect the peripheral parts of the retina with the optic papilla, where the nerve fibres turn to emerge from the eyeball, are much longer than those which connect the fovea and the macula with the papilla. It would therefore be anticipated that an interference with the retinal blood supply would affect the long peripheral fibres, but might permit the short central ones to escape, as is found to be the case.

On these grounds it does not appear necessary to assume that the escape of the central part is due to the presence of some special biochemical mechanism which is not found elsewhere in the retina.

(3) In the course of my duties as a teacher to medical students, I have examined closely the fresh retinas of many animals. Yet never once do I remember seeing macular or foveal pigment. I have seen many human retinas which showed no macular pigment either; and I have also seen some human retinas which showed some pigment, but in the latter cases the pigment could be accounted for as being due, either to pathological changes during life, or to post-mortem staining after death. This is in conformity with the ideas of Gullstrand, who held the view that macular pigmentation is a post-mortem effect, and with those of Wolff (1948), who wrote on p. 103 of his book: "The yellow colour of the macula is best seen in post-mortem eyes in which the retina has already become clouded. It is not seen in perfectly fresh eyes, nor ordinarily with the ophthalmoscope".

With regard to the latter, it has been stated that the macular pigment can be seen when red-free light is employed in conjunction with an ophthalmoscope. In fact, what is observed is that the fovea has a slightly different tint from the rest of the retina, and this might be due either to absence of blood vessels, or to the greater thinness of the retina at the fovea, thus disclosing more clearly the underlying colour of the choroid; or to some other factor. No proof has ever been given that the difference is due to macula pigment.

Sometimes subjective evidence is put forward in favour of foveal pigmentation: This is of several different kinds; that when three colours, say, red, green and blue, are mixed in various proportions, in order to match the spectral colours in turn, then different observers are found to require different proportions of these colours, and this is claimed to be evidence for the existence of macular pigment which is said to be present to a greater extent in some people than in others. Now Wright employed a method of presentation which would eliminate the effects of macular pigment, if any were present; but even then, differences in the proportions of the three matching colours were still found to occur, thus clearly demonstrating the fact that some other explanation must be looked for. Another type of experiment is one in which a uniform purple field is looked at, whereupon most observers see for a short time a pink spot which coincides with the centre of the fovea. This coloured spot is stated to be due to the absorption of the blue component of the purple light by the yellow macular pigment, thus permitting the red component to be observed by itself. Two comments may be made: In the first place, why is the pink spot seen for so short a time, and is it because the macular pigment undergoes rapid bleaching? In the second place, why is the pink area a dot; should it not be a ring in view of the fact that, when pigment is present in post-mortem eyes, it is not found at the foot of the foveal pit but in the sides of the slopes which lead up to the macular plateau?

(4) Lastly, as evidence of foveal pigment, Dartnall and Thomson mention the so-called tritanopia, or blue blindness of the fovea.

Many experiments have convinced me that there are sharply localized differences between one part of the retina and another. In addition, it is well known that more general differences occur. Thus the colour vision of the peripheral retina differs from that of the central retina. But in one respect all parts are alike, namely, in becoming both yellow-blind and blue-blind when a reduction is made either in the light which illuminates a coloured object, or in the visual angle which that object subtends at the observer's eye. Thus a large test object measuring 50 cm. × 30 cm., consisting of alternating parallel blue and yellow bars, 6 mm. wide, is found, in average daylight, to lose all colour and to appear black and white when it subtends at the eye an average angle of

about three degrees. By fixing in turn objects situated around this test object, it is possible to test other parts of the retina in addition to the fovea and macula. In this way it can be shown that the loss of colour takes place everywhere, showing that normal colour vision has been replaced by dichromatic vision. If then it be true, as Dartnall and Thomson suggest, that these colour defects are due to macular pigment, the conclusion must be that this pigment is present everywhere, and is not found solely at the macula. Now the effects of macular pigment on colour vision can be tested easily by placing a suitable yellow colour filter in front of the observer's eye. When this is done, blue is replaced by black, and in this respect the effect of reducing light intensity and visual angle is imitated. But in the case of yellow the imitation is found to fail, because instead of yellow becoming pale grey or white, as it does when its intensity or its visual angle is reduced, it is found to remain unchanged when it is viewed through the yellow filter. There is also another difference: white paper remains white with a reduction either of visual angle or of light intensity, whereas it alters to yellow when the yellow filter is used. The conclusion is that a yellow pigment cannot be responsible for the changes in colour vision which are observed at small visual angles and at low light intensities.

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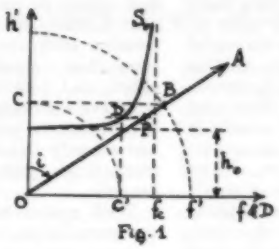


Fig. 1

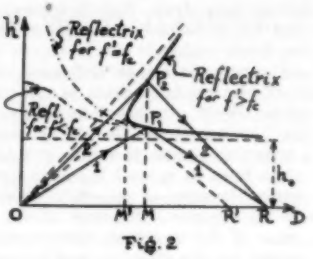


Fig. 2

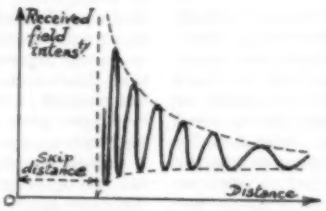


Fig. 3

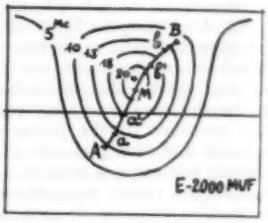


Fig. 4

FIELD INTENSITY AT THE RECEIVER AS A FUNCTION OF DISTANCE

Effect of the Ionic Distribution on the Unabsorbed Field Intensity as a Function of the Distance to the Transmitter

By P. LEJAY and D. LEPECHINSKY
Bureau Ionosphérique Français

FROM the characteristics of the reflecting layer defined by the $h'f$ trace (S_c in Fig. 1), it is possible to determine graphically the virtual path followed by a wave reflected by the ionosphere. Let us superpose on the f scale of the graph a second scale, identical to the vertical one, representing distances from the transmitter O. A wave, leaving the transmitter with an angle i, follows the path OA, which intersects at B the circle drawn with Of' as a radius. Projecting OB on the h'-axis and taking on the x-axis OC' equal to OC, we get on the f-scale a frequency $OC' = OC = OB \cos i = f' \cos i$. According to Martyns's theorem, the virtual height of the reflexion point of the f'-wave following the path OA is equal to that of the frequency OC' leaving the transmitter under normal incidence on the layer. The $h'f$ trace shows that this height is $C'D$; the point of reflexion will therefore be in P.

Repeating the same procedure for different angles i, one finds that reflexion points P form a continuous curve (which we shall call the 'reflectrix'), in the vertical plane considered, assuming the form of an inclined V with a horizontal branch when $f' > f_c$, and being like a dome overhanging the transmitter when $f' < f_c$.

It is seen immediately from Fig. 2 that $OR' = 2\,OM'$ is the skip distance; it is easy to measure the angles i for the two possible paths when $f' > f_c$ for distances greater than OR'; and one can recognize on a similar figure the only possible path when $f' < f_c$.

The earth and the ionospheric layer have been supposed flat. In the case of curved earth and curved ionosphere, the procedure is more laborious; but the reflectrix can nevertheless be found easily with fairly good approximation with the aid of the well-known 'transmission curves' of the standard method for obtaining the maximum usable frequency.

The reflectrix being known, it is easy to draw the curve denoting the variation of OR when the angle i varies from 0 to 90°, and the curve representing the variation of the spherical surface swept by the arc OR (in the case of the curved earth) when rotating around the vertical Oh', as a function of the angle i. Now, the transmitter being supposed isotropic, the power radiated in a cone having a vertical axis and an angle i is proportional to the corresponding solid angle. Thus one can read on the curves the increase of power ΔP and the increase of surface ΔS receiving the radiated power for an increase Δi. The ratio $\Delta P/\Delta S$, the power density resulting on the ground, will then be determined graphically.

This method shows very simply that the variation of the received field intensity is far from obeying the simple inverse distance law. In fact, there is a focusing effect not only at a distance corresponding to the path that leaves the transmitter tangentially to the earth surface (an already known fact) but also *at the limit of the skip distance.*

This is due to the fact that the field intensity is not only a function of the distance but also of the slope of the reflectrix at the point of reflexion and of the angles of departure i and of incidence i' on the ionosphere. In other words, the received field intensity depends on the frequency and on the height and ionization gradient of the reflecting layer.

It can be shown[1] that the power density received at ground-level on a plane surface normal to the wave-path considered is given by:

$$d_n = \frac{P \operatorname{tg} i}{4\pi R^2 [\sin D/R] \times \frac{\operatorname{tg}\beta(\operatorname{tg} i - \operatorname{tg} i')}{\operatorname{tg} i(\operatorname{tg} i' + \operatorname{tg}\beta)}}$$

P being the total radiated power by the point-like isotropic radiator, R the radius of the earth and β the slope of the reflectrix in degrees.

Unabsorbed received field intensity can be computed in the same way for a multi-hop path. It is found that, in the case of a perfectly reflecting ground, when the reflectrix is almost parallel to the ground the energy may be received by an infinite number of paths and the field intensity may be almost double that due to a single hop mode.

We have represented in Fig. 2 the two paths followed by the waves to reach a point beyond the skip distance when $f' > f_c$. These waves reaching the receiver being out of phase, one can expect maxima and minima of the received field along the great circle passing through the transmitter and the receiver. It can be shown that these maxima and minima are quite close to each other near the skip zone limit and tend to be more and more distant from each other with increasing distance from the transmitter. Received field intensity is represented as a function of distance from the transmitter in Fig. 3.

This seems to indicate that even a slight alteration of the ionization or height of the reflecting layer is able to cause a serious fading at a point not too distant from the skip zone.

[1] Note préliminaire, Laboratoire National de Radioélectricité, No. 121 (October 1948).

'M-Mode' Propagation Possibilities

By D. LEPECHINSKY
Bureau Ionosphérique Français

THE E-layer ionization depending almost exactly on the sun's angle of elevation, the usual E-2,000-MUF (maximum usable frequency) charts are formed of contours of equal frequency surrounding the subsolar point (see Fig. 4).

Let us consider a radio communication great-circle path between points A and B. At the hour corresponding to the position of the path AB shown in Fig. 4, the ion density of the E-layer is a maximum near the middle of the path and decreases towards its ends. In these circumstances, a wave of a sufficiently high frequency leaving the transmitter A at oblique incidence penetrates the E-layer at a, is reflected by the F_2-layer at a', then comes down on the E-layer at M, but being unable to penetrate it there because of the higher ion density of the E-layer at this point, is reflected back to the F_2-layer, which reflects it down again at b'. The wave then penetrates the E-layer at b, where the ion density is almost the same as at a, and reaches finally the receiver B. This mode of propagation is called a two-hop 'M-mode'. Multi-hop M-modes over-ride the E-layer in a similar way.

The chief advantage of these modes is the low attenuation suffered by the wave that follows them.

One can expect 'M-modes' to be particularly effective on long-distance transmission paths entirely situated in daylight, when normal field intensity at the receiver is low because of severe attenuation of normal multi-hop communication due to ground-reflexion losses and to high absorption in the D-region, which has to be traversed several times by the wave before it reaches the receiver.

A practical method of prediction of the rather narrow frequency band normally propagated by the 'M-modes' and of the corresponding rather short intervals of time can easily be devised. A set of auxiliary curves permits the rapid location, on the great circle path joining the transmitter to the receiver, of both D-region penetration points and of the intermediate 'upper' reflexion points on the E-layer. A simple method of computation of the received field intensity and thus of the gain due to the 'M-modes' is also easily devised. Predictions of 'M-mode' propagation are now worked out by the Bureau Ionosphérique Français[1].

Outstandingly good reception obtained regularly in March 1949 at about 7 00 a.m. (G.M.T.) on about 19 Mc./s. between Saigon and Tananariff (Madagascar) and in May 1949 at about 6 00 a.m. (G.M.T.) on about 14 Mc./s. between Paris and Numea (New Caledonia), seem to be in close agreement with 'M-mode' predictions by this method for these transmissions.

Focusing effects and 'M-mode' propagation thus appear to have an important influence on the field intensity at the receiver, and it is felt that it is no longer permissible to neglect them in prediction work.

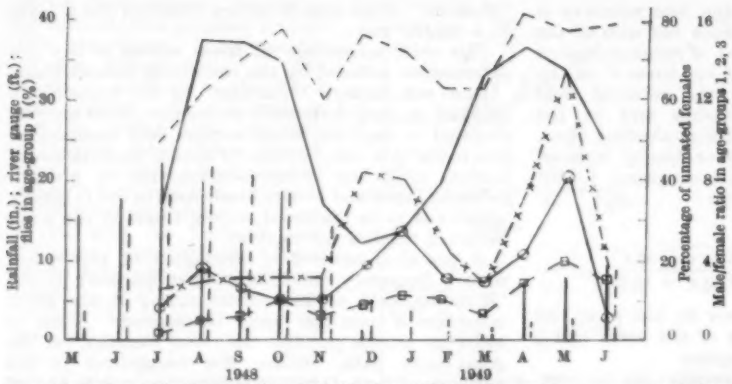
[1] Note préliminaire, Laboratoire National de Radioélectricité, No. 130 (May 1949).

AGE-GROUPING OF TSETSE-FLIES AS AN AID IN THE STUDY OF THEIR BIONOMICS

By F. A. SQUIRE
Department of Agriculture, Sierra Leone

THE following observations on *Glossina palpalis* R-D were made in Sierra Leone at Njala on the River Taia about 8° 5′ N. and 12° 5′ W. during the period July 1948–June 1949. Some five thousand flies were collected and examined. As it was not possible in the circumstances to adopt Jackson's[1] more elaborate method, a simplified system of age-grouping was devised. The catches were classified into three age-groups according to wing tear and colour: $AG1$ smoky wings; $AG2$ wings turning tawny; $AG3$ wings tawny and frayed. Monthly summaries were made and the percentage of flies in each age-group calculated; the ratio male/female (R) was recorded separately for each age-group; the total number of flies per man-hour (H) estimated; and the number of unmated females (V) was noted and expressed as a percentage of the females in $AG1$. The results are summed up in the accompanying table and graph.

Considering first the percentage of flies in $AG1$, it will be seen that emergence must continue fairly


Rainfall (in.); river gauge (ft.); flies in age-group 1 (%)
Percentage of unmated females
Male/female ratio in age-groups 1, 2, 3
M J J A S O N D J F M A M J
1948
1949

Vertical unbroken ordinates, rainfall; vertical broken ordinates, river gauge; – – – –, percentage of flies in age-group 1; ———, percentage of unmated females; □—□—, male/female ratio in age-group 1; ×—×—, male/female ratio in age-group 2; o—o—, male/female ratio in age-group 3

actively all the year round, since *AG*1 is never less than 24·8 per cent. Thus the widely accepted and not unreasonable belief that emergence ceases when the puparial sites are inundated appears to have no foundation in fact. The lowest value was recorded in July, when the river had by no means attained its highest level, and the value was actually on the increase in August and September when the riverine puparial sites were covered. The highest value, 41·1 per cent, was recorded in April at the beginning of the rains. The mean monthly figure was 34·4 per cent, so that seasonal differences are not very pronounced.

A more satisfactory measure of the rate of emergence is the number of unmated females, *V*. Nearly all females are mated within a few days of emergence, judging by the fact that practically all unmated flies are extremely teneral. Unmated females are readily distinguishable by the absence of mating scars. It will be seen that there are two peaks of emergence: during the wettest, and again during the hottest if not driest months. The lowest values are recorded in December–January, two of the driest months owing to the cessation of the rains and the prevalence of that dry, desert wind, the Harmattan; and again in June–July, two months of high rainfall. The rainy season emergence peak is of special interest since it raises the question: Where do the flies emerge? The riverine puparial sites are by this time several feet under water. There are three alternatives: the pupæ remain viable and the flies emerge through the overburden of water; the puparia are dislodged and washed up on the riverine beaches where they hatch; the fly anticipates events and larviposits in extra-riverine sites. The last is probably the true explanation.

In order to understand this periodicity of emergence, it is necessary to study the gestation cycle. This is represented by the ratio male/female *R*, in *AG*1, *AG*2 and *AG*3, since pregnant females are more chary and therefore comparatively rare in catches. *R* shows the greatest variation in *AG*2, the procreant group *par excellence*, somewhat less in *AG*3, and least in *AG*1, which consists of young flies up to about fifteen days old. It will be observed that the ratio is low throughout the rains, and it may be concluded from this that conditions at this time do not greatly favour gestation. The hot dry months of February and March again adversely affect gestation, while the most favourable seasons appear to be May and December, that is, at the beginning and at the end of the rains. Allowing for the time-lag due to the maturation of the larvæ and to the pupal period, it will be seen that the gestation peaks in December–January and in May probably result in the emergence peaks of April and August respectively. It may be objected that seasonal food scarcity might cause even pregnant females to flock to the 'fly-boys'. This factor is not judged to be appreciable in Sierra Leone, where the food supply, though not abundant, is static.

Comparing *R* in the three age-groups, it will be seen that they all follow the same seasonal trend, and that *R* is almost consistently highest in *AG*2 and lowest in *AG*1. The frequent references in literature to the ratio male/female ignoring the age of the flies may therefore be very misleading. *AG*1 being the least procreant of the age-groups, it is not surprising to find that *R* here is consistently the nearest to the true natural ratio of unity. In theory, it may be assumed that when $R = 1$ there is no gestation in progress. In practice, this is not necessarily so, for there will always be some pregnant females that will be caught, thus reducing the value of *R*. At the other extreme, it would be unwise to assume that the highest value of *R* recorded, namely, 13·6, represents 100 per cent pregnancy. If then $R = 1$ is assumed to represent, say, 5 per cent pregnancy, the highest gestation-rate recorded in terms of pregnant females would be, in May: *AG*1, 17; *AG*2, 68; *AG*3, 41 per cent of the females in each age group; and the lowest, in July: *AG*1, 4; *AG*2, 12; *AG*3, 8·5 per cent.

The number of flies caught per man-hour (*H*) given in the table revealed but little variation, and is not shown in the graph. The highest average monthly figure (7·6) was recorded in May, and the lowest (1·9) in November. There was a second peak in September (2·8). Thus the peaks coincide with the peaks of unmated females (*V*). This poor rate of collection of flies is characteristic of the general low numerical status of *Glossina palpalis* in Sierra Leone.

[1] Jackson, C. H. N., *Bull. Ent. Res.*, **37**, 2; **39**, 3.

Monthly summary of flies collected

Month	*AG*1 %	*AG*1 *R*	*AG*2 %	*AG*2 *R*	*AG*3 %	*AG*3 *R*	*H*	*V*	Total
1948									
July	24·8	0·9	53·1	2·5	22·1	1·7	1·9	31·6	145
August	30·4	1·2	53·7	2·8	15·9	3·7	2·7	75·4	415
September	34·8	1·5	51·5	3·0	13·7	2·7	2·8	75·0	431
October	38·6	2·4	43·7	2·8	17·7	2·1	2·1	69·9	345
November	28·9	1·5	48·8	3·1	22·3	2·1	1·9	33·3	360
December	38·1	1·9	44·5	8·3	17·4	3·8	2·0	25·0	441
1949									
January	36·0	2·3	41·4	8·0	22·6	5·4	2·2	25·8	283
February	31·6	2·2	49·4	4·8	19·0	3·1	3·5	39·7	398
March	31·5	1·7	49·6	2·6	18·9	3·1	3·9	66·0	397
April	41·1	2·6	41·8	7·2	17·1	4·4	5·2	74·0	909
May	38·5	3·4	49·5	13·6	12·0	8·2	7·6	67·6	384
June	38·7	2·9	45·0	3·7	16·3	1·4	2·7	50·0	271

HISTORICAL CHEMISTRY COLLECTIONS AT THE UNIVERSITY OF ST. ANDREWS

A VALUABLE gift of more than eighty books dealing with historical chemistry has recently been made to the library of the Chemistry Department, United College, University of St. Andrews, by Dr. Leonard Dobbin, the doyen of Scottish chemists and a leading authority on the history of his science. Many of these books are rare, and the addition will strengthen notably one of the outstanding collections of the kind in Great Britain. Besides a reference section in constant use by research students and members of the chemistry classes, this departmental library contains a collection of great interest, comprising books, manuscripts, holograph letters, portraits, engravings, and even a few paintings, dealing with alchemy and historical chemistry. The oldest manuscript is a Latin collection of early treatises on alchemy, of the fourteenth century, and there is a fine copy of the first printed work by any Scots man of science—the "Physionomia" of Michael Scot, published in Venice in 1477.

Among other items are some holograph writings on alchemy by Sir Isaac Newton, and an unusually complete set of the alchemical books of Count Michael Maier, "the musical alchemist of Prague". There is also a handsome copy of Agricola's "De Re Metallica" (Basle, 1561), bearing the signature of the second professor to hold the chair, M. F. Heddle, by whom it was bound in leather; this book came back to the Department in a romantic way in 1931. A set of John Dalton's "New System of Chemical Philosophy" bears an inscription in the author's handwriting to his friend, Dr. Joseph Ransome.

Of the total of nearly three thousand volumes in this library, about one-third belong to the historical section. An original small nucleus consisted of books formerly belonging to Prof. Arthur Connell, the first occupant of the chair (1840–62); but most of the items have been acquired during the term of office of the present incumbent, Prof. John Read. Many of them have been described in Prof. Read's recent trilogy of historical works, "Prelude to Chemistry", "Humour and Humanism in Chemistry" and "The Alchemist in Life, Literature and Art". Owing to the cramped accommodation in the Department, it is impossible to do justice to these collections of books, etc., which call urgently for safer housing and an effective system of display. During the past few years a connexion has been established between this library and the Edgar Fahs Smith Collection in the University of Pennsylvania, and Prof. Read has become associate editor of *Chymia*, an annual publication devoted to historical chemistry and emanating from the University of Pennsylvania.

The St. Andrews collection is supplemented by more than two thousand lantern slides, many of which deal with historical chemistry and have been reproduced from original sources. Cognate research collections illustrate by means of original specimens the investigations that have been carried out in the Department, since the days of Purdie, in the fields of stereochemistry, carbohydrate chemistry and terpene chemistry; and there are also some items of Australian interest. In addition, the library contains a balance of 1750 with a 37-inch beam, and a collection of chemical apparatus dating from the days of Black and Priestley in the latter half of the eighteenth century. This apparatus, found in the ancient tower of St. Salvator's Chapel about 1925, includes crucibles, earthenware retorts, glass alembics, a magnificent glass matrass six feet in height, and other items. It is likely that this apparatus was bought in 1811 from Dr. Thomas Thomson, another historian of chemistry, who disposed of a good deal of chemical apparatus to the University of St. Andrews when he resigned his chemistry lectureship at Edinburgh in that year.

AMSTERDAM CONFERENCE ON ION SOURCES

MORE than fifty people, including visitors from Belgium, France, Great Britain, Sweden and Yugoslavia, attended a Conference on Ion Sources which was held in the Zeeman Laboratory in Amsterdam during November 15–16, 1949. Prof. C. J. Bakker, director of the Dutch Institute for Nuclear Physics, opened the Conference, warmly welcoming the foreign participants, and briefly surveying the general problems in ion-source design and operation.

The first speaker, Dr. P. C. Thonemann (Oxford), described the development work on the high-frequency ion source. The principal points discussed included (*a*) the space-charge flow of ions through a metal canal, (*b*) production of a high concentration of atomic gas in the discharge space, and its relation to the proton percentage in the ion beam, (*c*) the extraction and focusing of ions into a canal, and (*d*) the energy inhomogeneity of the ions. Ion currents of 1 m.amp. containing more than 90 per cent protons have been recorded. The paper was illustrated by slides.

Experiments performed with ion sources of the Finkelstein and Penning type were dealt with by Mr. P. V. Veenstra (Utrecht). The discharge current varies with both the anode potential and magnetic field. The position of the maximum current depends only on the anode potential, and its magnitude varies with pressure. If the gas pressure is increased from a low value, a point is reached at which the slowly increasing discharge-current jumps to about five times its initial value. A similar phenomenon occurs with increasing magnetic field. On reducing either pressure or magnetic field, a marked hysteresis is observed. The condition of large discharge-currents Mr. Veenstra termed "the super state", and he reported strong high-frequency oscillations in this state. From both sources he reported currents of about 1 m.amp. (50 per cent protons). Dr. Thonemann suggested that the initiation of the 'super state' corresponds to the formation of a plasma at a potential positive to the cathode. Bombardment of the cathode by positive ions thus enhances the electron emission, and the discharge then shows all the characteristics associated with the low-voltage arc.

In the afternoon short papers were read. Mr. R. Björnerstedt (Stockholm) reported experiments on a Zinn-type ion source and the precautions necessary to obtain an unambiguous measure of the ion current. It has been noticed that the focused ion currents show a dependence on the probe material. Major E. Thomas (Brussels) read a paper on a high-frequency

ion source under construction for a cascade generator of 1·4 MeV. Mr. M. E. Reinders (Amsterdam) pointed out that in the Nier-type source used in his mass spectrometer the electron beam forms a potential trough which may prevent molecular ions escaping while atomic ions, formed with considerable kinetic energy, escape readily. Thus maximum currents of H^+ and D^+ are obtained with electron currents of 500 μamp., whereas the molecular ion currents of H_2^+ and HD^+ are a maximum for currents of 1 μamp. This discrimination must be considered when, for example, the relative abundance of hydrogen and deuterium are being compared by the atomic ions. The difference in the nuclear separation of diatomic hydrogen and deuterium leads, on dissociation by electron bombardment, to different kinetic energies of the monatomic ions. The same afternoon the Laboratory for Mass Spectrography was visited, and the magnetic ion source of the Heil type was demonstrated. A 180° isotope separator (100-cm. radius) is under construction.

On November 16, Dr. M. Hoyaux (Charleroi) read a paper on "Cyclotron Ion Sources". After reviewing the earlier types of sources, he discussed in some detail the physical and mathematical problems associated with the adaptation of the Von Ardenne-type source for use in a cyclotron. Using as a basis the Broullin theory of the magnetron, he sketched the extension necessary to include the effect of gas collisions on the radial electron density and potential distribution. Theoretical work on the extraction mechanism is being pursued. Experiments at Charleroi on high-frequency ion sources for cyclotrons are due to begin.

The next speaker, Dr. J. Kistemaker (Amsterdam), discussed "Physical Problems in High-Intensity Ion Sources". He divided the subject into three main problems: (*a*) Production of ions in the discharge: for a given filament emission current, a maximum number of ions can be produced by choosing the correct accelerating voltage and increasing to a maximum the total electron path (for example, an oscillating electron source using an axial magnetic field). (*b*) Transport of ions to the exit opening: the potential distribution in the discharge must be such that the ions converge towards the exit opening and are drawn from a volume of intense ionization. (*c*) Extraction of ions: the ion currents are limited by space charge, and sufficient ions must drain towards the exit opening so that penetration of the extracting field into the discharge is not sufficient to extinguish it. Various questions of gas economy were discussed. An ion source has been constructed in which 50 per cent of the total flow through the exit opening are ions. At a gas pressure of 6×10^{-5} mm. of mercury and an extraction voltage of 8 kV., 6 m.amp. of helium ions were measured passing through an exit 1 cm. in diameter.

In the afternoon, Dr. C. Cassignol (Paris) discussed the "Extraction and Focusing of Ion Beams". He mentioned a promising type of magnetron ion source consisting of two short concentric cylinders in which the outer is the anode and the inner a perforated cathode. Due to the extended electron paths, intense ionization is produced at low pressures, and part of the ion current passes through the cathode and is extracted in an axial direction. Experimental results are not yet available. Some interesting information about the operation of the ion source in the Nier isotope separator was given by Dr. R. Bernas (Paris). He has observed that with increasing magnetic field the initial ion current (2 m.amp. focused beam) suddenly drops practically to zero while the probe and discharge current both increase. It is suggested that a sudden transition to a 'super state' completely altered the previous condition in this source, and the ion beam issuing from the exit slit was then widely divergent. Dr. P. M. Endt (Utrecht) then described some experiments on a pulsed Finkelstein source.

In the final talk of the session, Dr. H. Brinkman (Arnhem) suggested that very pure proton currents could be obtained by ionizing hydrogen in a tungsten cylinder maintained at 2,500° C. At sufficiently low pressures, dissociation of molecular hydrogen is practically complete at this temperature. An anode placed in the tungsten cylinder serves to accelerate the electrons. The Conference was closed by a visit to the 30-MeV. synchro-cyclotron in the Institute of Nuclear Physics.

C. J. ZILVERSCHOON

EDUCATION IN BOLIVIA

ANOTHER of the series of basic studies on education in certain Central and South American countries has been prepared under the ægis of the United States Office of Education. The studies are part of a programme to promote understanding of educational conditions in the American countries and to encourage co-operation in the field of inter-American education. Begun in 1943, the project involves travel by Office of Education specialists in the various countries to gather first-hand information on their educational systems and the preparation of reports from these data for publication. "Education in Bolivia" is based on data gathered by R. H. Nelson in Bolivia in 1947 and supplemented since then through documentation (Washington, D.C.: Government Printing Office).

Situated in the west-central region of South America, Bolivia is one of the two countries in the western hemisphere without a sea coast or sea port. Its area is estimated at half a million square miles, which is roughly ten times the size of England. Two principal mountain ranges cross the country from north-west to south-east. Between these ranges lies the High Plain, the largest and highest plateau in the western hemisphere, from which Bolivia gets the popular name of the "Land in the Sky". To the east, in the lowlands of the Amazon and Parana Plain, lies a tropical and sub-tropical section which comprises almost two-thirds of the total area of the Republic. In the highland plateau and the valleys leading eastwards from it are located the largest and most important cities of the Republic, La Paz, Cochabamba, Sucre, Potosi and Oruro.

The climate ranges from tropical heat in the eastern section to arctic cold in the mountains and high plains of the west. In the valleys to the east the climate is temperate. In both these regions the soil is largely poor and thin, but supports a meagre agriculture which supplies in part the needs of the peoples of these areas. In the eastern two-thirds of the country the possibilities of agricultural production are rich, although at present this area is sparsely populated and virtually undeveloped.

The 1,400 miles of railways in Bolivia form a system which connects the principal cities. Road and railway construction are enormously expensive in the rugged mountain areas, and a serious defect in the transportation is the lack of road and railway connexions with the eastern lowlands. Two principal

airlines render efficient service among the main cities.

Tin is by far the leading export of Bolivia, which produces 15 per cent of the world's supply. Other metals exist in the mountains of the Republic and represent potential national wealth. The principal agricultural products include coca leaves from which cocaine is made, cinchona bark, rubber, animal products (hides and wool) and nuts. There is little or no manufacture in the country. Nothing is produced for export, and only a small amount for domestic consumption.

Under the constitution of 1938 the Republic of Bolivia has a representative government of three branches. The executive power is vested in a president, elected by direct suffrage for four years, and his appointed cabinet. The legislative division consists of a bicameral congress with a senate and chamber of deputies. All men of twenty-one years of age who can read and write are privileged to vote.

Of the estimated 3½ million people who make up the population of Bolivia, approximately 1½ million are Indian, 500,000 are white, principally of Spanish descent, and the remainder are of mixed blood. The Indians have good physique and constitute a great potential asset to their country if their social status could be improved through education and legislation. About 80 per cent of the population inhabit the highland one-third of the country's area and contribute to the mining industry. According to recent estimates, 75 per cent of the people of Bolivia are illiterate; most of these live in rural areas where schools are not available.

The recognized national religion is Roman Catholic; but other religions are permitted. Spanish is the national language; but the Aymara and Quechua tongues are spoken by most of the Indian and mestizo portions of the population.

Before the coming of the Spaniards in the sixteenth century, the culture of the Aymara and Quechua Indians was preserved and handed on from one generation to the next by word of mouth. To-day, public education in the elementary, secondary, rural, vocational and normal schools is under the administration and supervisory control of the Minister of Education, Fine Arts and Current Affairs. The great problem of Bolivian education lies in the relationship between the country's financial ability and the enormous need for increased educational facilities. In 1943 it was estimated that only 23·8 per cent of the 600,000 children of school age (7–14 years) were in daily attendance at school. While it is true that educational facilities have improved since 1943, even at a most generous estimate far less than half the nation's children attended any school at all in 1948. The most hopeful aspect of this situation is the fact that the people of Bolivia are aware of the need for educational facilities and are making a progressive effort to find the solution to this problem.

In the rest of his report Nelson examines the different stages in Bolivian education in considerable detail; the following features should be of special interest to educationists.

The problem of school attendance, especially in the elementary school, is serious owing to such factors as lack of transportation, illness, necessity for students to work and parental apathy or irresponsibility towards the question of schooling. Much is being done through the medium of parent-teacher groups to bring about a realization of the need for education of young children. These parent-teacher groups are also making a serious effort to combat the prevalent idea that education is not as necessary for girls as for boys.

The traditional method of instruction in Bolivian schools, as in schools of some other Latin-American republics, involves dictation of factual material by the teacher and transcription of this material verbatim by the student into a set of carefully kept notebooks. Recitation is formal and stereotyped, the student being expected to stand when called upon and repeat verbatim the dictated material requested; free class discussion is not used as a method of instruction. The scarcity of text-books in Bolivian elementary schools is a serious handicap to teaching and especially to the teaching of reading.

Of the 309 urban elementary schools, thirty-four are night schools. A few of these are open to adults who wish to get an elementary education which they missed in their youth; but the large part of the night-school student body is made up of children who work during the day. Some of those who work on farms come from distances of ten or fifteen miles.

The only requirement for admission to a secondary school beyond the usual proofs of good health and good character is the completion of the six-year elementary school course. Despite this, the secondary school enrolment of 14,821 students is less than 8 per cent of the total school enrolment. Tuition in the public secondary schools is free, and the instruction is much the same as in elementary schools. This has the sanction of long usage and is considered the most practical method in view of the fact that almost no text-books or reference books are available.

Vocational education is a comparatively new development in Bolivian education, having first been introduced about 1942. Its inclusion in the school programme is thus still in an experimental stage. There are eight vocational schools for girls, seven industrial schools for boys and five commercial schools. In addition to these schools, four of the universities maintain institutes for certain types of technical training on the secondary level. These offer four years of training in mechanics, electricity, foundry and graphic arts. The stated object of the girls' vocational schools is to "complete the general education of women and to prepare them for the exercise of the manual occupations suitable to their sex".

Teacher training is carried out at various colleges, one of which, the National Teachers' School at Sucre, has operated continuously since its foundation in 1909. As part of the course in pedagogy and teaching methods, students are required to spend one hour per week during the third year of their course in observation of actual classroom teaching, and during the fourth year they are required to teach one hour a week for twenty-four weeks under the supervision of a methods instructor and a classroom teacher.

There are seven universities in Bolivia, all of which, as well as any which may later be created, constitute a national entity known as the Bolivian University. The aims and functions of the Bolivian University are as follows: "The Bolivian university will give impulse to the scientific investigation of university problems with the object of enriching the cultural patrimony of the university and it will especially undertake those national problems related to the development of the natural wealth of the country". As in other South American republics, the university congress includes student members.

T. H. Hawkins

SIZE AND DISTRIBUTION OF INCOME IN GREAT BRITAIN

THE Oxford University Institute of Statistics has reprinted five essays by Dudley Seers which appeared in the *Bulletin* during 1948*. They make a brave attempt to estimate some of the more interesting economic quantities, to calculate a non-working-class cost-of-living index, to use it to examine the changes in the distribution of the real national income, and to correct the national product estimates for price changes, so as to obtain comparative figures for the pre- and post-war allocations of productive resources between different uses.

Estimates are first obtained of middle-class (here used throughout to mean non-working-class) expenditure in 1938 by subtracting from the official estimates of total expenditure given in the National Income White Papers estimates of working-class expenditure derived from the 1938 Ministry of Labour cost-of-living inquiry. The results reveal some interesting discrepancies between the two estimates from the different sources, discrepancies which cannot be resolved owing to the official reticence about the method of deriving the 1938 White Paper consumption estimates. This seems a good example of the type of result which is often found when the results of a statistical inquiry are checked against other data.

The next essay is devoted to an attempt to discover the change in the working-class cost of living between 1938 and 1947 as calculated (but not published) by the Technical Committee on the Cost-of-Living Index. The third essay uses the weights obtained in the first essay to calculate the change in middle-class cost of living since 1938. Both indexes are brought up to date to September 1948. In the fourth essay an analysis of real changes in the national income, its uses and origin, is made for the war years. The last essay considers the use of the Interim Index of Retail Prices as an index of working-class cost of living at present and concludes that the errors involved in this procedure cancel each other.

The most important conclusions of the essays occur in the following two short tables.

	£ millions, at 1947 prices		
	1938	1947	Change
Working-class real income (net of taxes)	4,348	4,735	+387
Middle-class real income (net of taxes)	3,599	3,354	−245

CAUSES OF THE INCREASED NATIONAL DEFICIT

		£ millions (1947 prices)
Deficit in 1938		70
Effect of changes in terms of trade (including invisibles)		+300
Effect of changes in national outlay since 1938:		
More private consumption	+100	
More investment (gross)	+330	
More military spending	+450	
More current government spending	+480	
	+1,360	
Effect of increased national production since 1938:		
More production for home market	−1,780	
More exports of goods	−70	
Less exports of services	+800	
	−1,050	
Net effect of changes in outlay and production since 1938		+310
Deficit in 1947		680

Mr. Seers gives an estimate of the changes in industrial production between 1938 and 1946, here defined as the gross product of industry in the widest sense, including agriculture and commerce, transport and the entertainment industry. The fourth essay indicates an increase of output of 8 per cent, accompanied by an increase of 9 per cent in productivity per man-year. This may be compared with the decrease of 4 per cent indicated by the official index of production over the same period (using the comparable 1946 weighted index), and the decrease of 2 per cent recorded by the London and Cambridge index over the same period. The difference between these results are presumably largely due to differences of coverage.

The margin of error attached to most of the results obtained is obviously large. They are probably the best estimates available with the present sources, and the economist is indebted to Mr. Seers and the Institute for producing them in this collected form. They do, however, direct attention to an outstanding gap in the economists' statistical information. More facts are urgently required on the spending and saving behaviour of the middle and upper classes. This can only be achieved by carrying out sample inquiries, which with advantage might be arranged to cover all the social classes and to obtain information on total expenditure in a form suitable for comparison with retail trade statistics.

J. D. SARGAN

* Changes in the Cost of Living and the Distribution of Income since 1938. By Dudley Seers. (Oxford University Institute of Statistics.)

INDIAN LAC RESEARCH INSTITUTE

ANNUAL REPORT FOR 1947–48

THE annual report for 1947–48 of the Indian Lac Research Institute, stationed at Ranchi, Bihar, has been issued from Namkum, Ranchi, dated 1949. The Institute has been suffering from want of several items of supply, among which are chemicals and apparatus which, as former annual reports show, have been in deficit for some time. This want is proving a severe handicap to the Institute, in which many people are interested, for a number visited it during the year.

A certain amount of training is given to students both in the industrial uses of lac and in the important methods of cultivation. Since the early days of lac production in what was the old Chota Nagpur Division, lac has certainly made a very considerable advance. It is interesting to note that in the early days of inquiry towards the end of last century and the beginning of the present, very little was known about the insect pests attacking lac or the most suitable methods of pruning, and seasons to prune, such good lac trees as *Palas*, *Butea frondosa* and the *Schleichera trijuga*. A great advance has been made in these investigations at the Ranchi Institute. Some of the anti-insect investigations are of very considerable interest. It is said that sugar cane, cotton, pea, brinjal, hibiscus and maize were grown in a small area to obtain larvæ of the lepidopterous pests from these plants for use as alternative hosts for laboratory breeding. Useful work has also been done in the chemical section.

As a result of an inquiry from a firm in Calcutta, experiments were undertaken with the view of utilizing photographic film scrap in combination with shellac for producing suitable spraying or brushing lacquers. It was found that a lacquer containing about 20 per cent of the film scrap on the weight of lac gave films of good clarity, gloss and hardness, but the water resistance of the film was low.

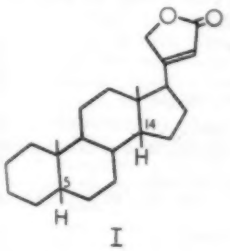
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Nomenclature of the Cardiac Aglycones, Toad Poisons and Steroid Sapogenins

THE nomenclature of these groups of steroids is at present unsatisfactory. The trivial names tell the reader nothing about the structure of the compounds, and many names are so similar as to be confusing even to workers familiar with the substances, for example, digoxigenin, digitoxigenin, digitogenin. The systematic names of the aglycones based on the names of the bile acids are very lengthy and are rarely used—digoxigenin, for example, may be called 3α : 12β : 14 : 21-tetrahydroxy-14-*iso*-*nor*chol-20(22)-enic acid lactone (23 → 21); but the name is scarcely convenient. Since much work is being done on these compounds at present, and since steroid nomenclature is to be discussed at the next meeting of the International Union of Chemistry in 1951, it seems appropriate to offer some proposals for the systematic nomenclature of these compounds.

It is suggested that new names should be introduced for a few fundamental structures, and that the naturally occurring substances and their derivatives should be named as substitution products of these. (In these notes the indices α and β are shown without parentheses, following the suggestions of Fieser and Fieser[1].)



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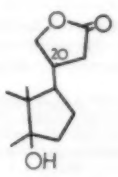

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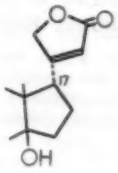

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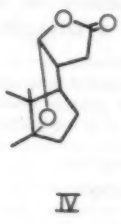

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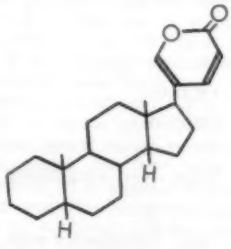

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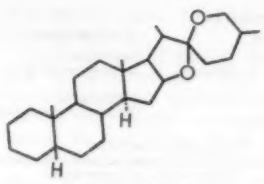

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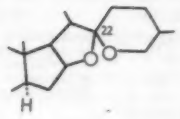

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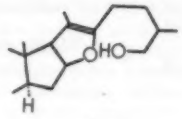

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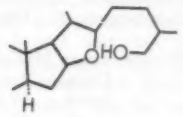

IX

Cardiac aglycones. Most cardiac aglycones are derivatives of the 14-*iso*-*nor*cholenic acid lactone I, which might be called *digitenolide*—indicating the source of the compounds and their unsaturated lactone character. Digitoxigenin would then be named 3β : 14β-dihydroxydigitenolide; its analogue odorigenin B (= uzarigenin ?) (Rangaswami and Reichstein[2]), which has the 5-*allo* configuration, would then be 3β : 14β-dihydroxy-5-*allo*-digitenolide. For further examples, see Table 1.

Table 1. PROPOSED SYSTEMATIC NAMES FOR SOME CARDIAC AGLYCONES AND TOAD POISONS

(Proposed name = prefix + stem name; for example, strophanthidin = 3β : 5β : 14β-trihydroxy-19-aldodigitenolide)

Prefix	Stem name: Digitenolide	Bufadienolide
3β : 14β-Dihydroxy	Digitoxigenin	Bufalin
3β : 5β : 14β-Trihydroxy	Periplogenin	Telocinobufagin
3β : 11α : 14β-Trihydroxy	Sarmentogenin	Gamabufotalin
3α : 12β : 14β-Trihydroxy	Digoxigenin	—
3β : 14β : 16-Trihydroxy	Gitoxigenin	—
3β : 14β-Dihydroxy-16-acetoxy	Oleandrigenin	Bufotalin
3β : 5β : 14β : 19-Tetrahydroxy	Strophanthidol	Hellebrigenol
3β : 5β : 14β-Trihydroxy-19-aldo	Strophanthidin	Hellebrigenin

Derivatives of the genins in which the 14-*iso*-structure is preserved might be named similarly:

Table 2

Formula	Old name	New name
II	Dihydrogenin	14β-Hydroxydigitanolide (and -20-*iso*-digitanolide)
III	*allo*-Genin	14β-Hydroxy-17-*iso*-digitenolide
IV	*iso*-Genin	17-Digitenolide

Toad poisons. These compounds are derivatives of the 14-*iso*-choladienic acid lactone structure V, which might be called *bufadienolide*.

Thus bufalin (Meyer[3]) would be 3β : 14β-dihydroxybufadienolide. Table 1 gives the proposed systematic names of some cardiac aglycones and toad poisons. The proposed names are not awkwardly long, and they express the interrelationships of the compounds in a way that trivial names can never do.

The table makes obvious the fact that the toad poisons recently studied by Meyer[3,4]—see also Schmutz[5]—agree in the position and configuration of their substituents with the cardiac aglycones (for references to the latter, see Fieser and Fieser[1]).

Steroid sapogenins. These compounds are now formulated, following Marker and Rohrmann[6], as spiroketals. Their names might be based on the name *steroketal* VI. The following names are suggested:

Table 3

Formula	Old name	New name
VI	Sapogenin	Steroketal
VII	*iso*-Sapogenin (or a different trivial name)	22-*iso*-Steroketal
VIII	ψ-Sapogenin	ψ-Steroketal
IX	Dihydrosapogenin	Dihydro-ψ-steroketal

Examples:

Sarasapogenin	3β-Hydroxysteroketal
Tigogenin	3β-Hydroxy-5-*allo*-22-*iso*-steroketal
Neotigogenin	3β-Hydroxy-5-*allo*-steroketal
Diosgenin	3β-Hydroxy-Δ⁵-22-*iso*-steroketal

Compounds in which both oxide rings have been opened can best be named as derivatives of coprostane or cholestane, for example, tetrahydrosarsasapogenin = coprostane-3β : 16β : 26-triol.

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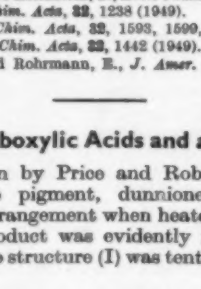
Dec. 14.

[1] Fieser, L. F., and Fieser, M., "Natural Products Related to Phenanthrene" (3rd edit. New York: Reinhold, 1949).
[2] Rangaswami, S., and Reichstein, T., *Helv. Chim. Acta*, **32**, 939 (1949).
[3] Meyer, K., *Helv. Chim. Acta*, **32**, 1238 (1949).
[4] Meyer, K., *Helv. Chim. Acta*, **32**, 1593, 1599, 1993 (1949).
[5] Schmutz, J., *Helv. Chim. Acta*, **32**, 1442 (1949).
[6] Marker, R. E., and Rohrmann, E., *J. Amer. Chem. Soc.*, **61**, 846 (1939).

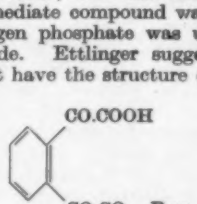
Indenone-Carboxylic Acids and *allo*-Dunnione

It was shown by Price and Robinson[1] that the naphthoquinone pigment, dunnione, undergoes a remarkable rearrangement when heated with aqueous alkali. The product was evidently not a naphthoquinone, and the structure (I) was tentatively assigned to it.



I

Confirmation of the structure of dunnione, and further examples of the rearrangement[2], suggested that the rapid reaction with alkali is related to the presence of a tertiary group on the quinone ring. We have found that 2-hydroxy-3-*tert.*-butyl-1 : 4-naphthoquinone is also readily rearranged to a yellow crystalline acid, isomeric with the quinone. This observation was made independently by Dr. Ettlinger of Harvard[3], who also discovered that a colourless intermediate compound was formed when disodium hydrogen phosphate was used instead of sodium hydroxide. Ettlinger suggested that this compound might have the structure (II):



II

Very similar results have since been reported by Shemyakin and co-workers[4] in a study of the action of weakly alkaline buffers on phthiocol. Two acidic products were obtained, and some evidence was given that these compounds were *o*-propionyl phenylglyoxylic acid and 2-methyl-indenone-3-carboxylic acid.

Fieser[5] reported the rearrangement of 2-hydroxy-3-*cyclo*-hexyl-1 : 4-naphthoquinone, and we have found that 2-hydroxy-3-*iso*-propyl-1 : 4-naphthoquinone also gives an isomeric yellow acid when heated with alkali. The reaction can therefore occur with hydroxy naphthoquinones having primary, secondary or tertiary alkyl groups; but the rate appears to be greatest with the tertiary alkyl compounds.

There has been little direct evidence that the yellow crystalline isomers obtained in these reactions are, in fact, indenone-carboxylic acid derivatives, but we now report the synthesis of 2-*iso*-propyl-indenone-3-carboxylic acid, which we have found to be identical with the product obtained by rearrangement of 2-hydroxy-3-*iso*-propyl-1 : 4-naphthoquinone.

Phenyl-*iso*-propyl-succinic acid[6] was cyclized with sulphuric acid to give 2-*iso*-propyl-indenone-3-carboxylic acid (m.p. 103–104°). The ethyl ester of this acid was brominated, and the resulting bromo-derivative was heated with diethylaniline. Alkaline hydrolysis of the resulting ester gave 2-*iso*-propyl-indenone-3-carboxylic acid; yellow needles from light petroleum, melting point 146–147° alone or mixed with the product obtained by rearrangement of 2-hydroxy-3-*iso*-propyl-1 : 4-naphthoquinone.

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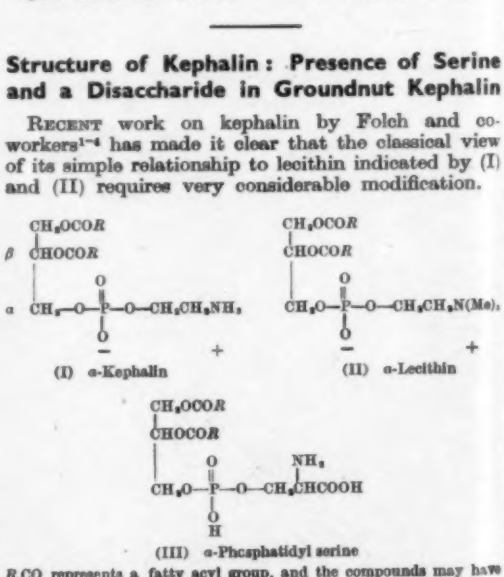
T. C. Somers

Organic Chemistry Laboratory,
University of Melbourne.
Sept. 28.

[1] Price and Robinson, *J. Chem. Soc.*, 1522 (1939).
[2] Cooke, *Nature*, **162**, 178 (1948).
[3] Private communication (July 1, 1948).
[4] Shchukina, Kondrat'eva and Shemyakin, *J. Gen. Chem.*, **18**, 2121 (1948).
[5] Fieser, *J. Amer. Chem. Soc.*, **70**, 3237 (1948).
[6] Upson and Thompson, *J. Amer. Chem. Soc.*, **44**, 181 (1922).

Structure of Kephalin: Presence of Serine and a Disaccharide in Groundnut Kephalin

Recent work on kephalin by Folch and co-workers[1–4] has made it clear that the classical view of its simple relationship to lecithin indicated by (I) and (II) requires very considerable modification.



R.CO represents a fatty acyl group, and the compounds may have either α- or β-glyceride structure.

Formula (I) has never, in fact, been entirely free from objection, since published analytical data are far too low in carbon, nitrogen and phosphorus. Moreover, it is not easy to explain on the basis of structures (I) and (II) the extreme insolubility in alcohol of kephalin, compared with lecithin, which forms the basis of their separation.

The problem has now been greatly clarified by the work of Folch, who has shown that the chief nitrogenous constituent of ox-brain kephalin is serine, although ethanolamine is present to a lesser extent. Further, he finds that compound (I) is freely soluble in alcohol, and is not, therefore, the substance usually referred to as kephalin, which is insoluble. Finally, he finds that ox-brain kephalin contains an alcohol-insoluble phosphatide which yields inositol, serine and glycerophosphoric acid on hydrolysis. These results go far to explain both the discordant analyses and the solubility anomaly.

It is clear from Folch's work that lecithin and kephalin, as commonly understood, are mixtures. Thus, lecithin, the fraction of greatest solubility in alcohol, is likely to consist of both (I) and (II) and possibly even (III) if the carboxyl group is free (as distinct from the sodium or potassium salt; many workers find potassium and sodium in kephalin, and we confirm this). For this reason Folch has proposed the terms phosphatidyl ethanolamine, phosphatidyl choline and phosphatidyl serine for (I), (II) and (III) respectively, and suggests that the names 'lecithin' and 'kephalin' be employed only for crude mixtures.

Although Folch's work has been confined to animal kephalin, there are sufficient analogies to anticipate parallel results with vegetable kephalin, and, indeed, both combined sugars and inositol have been reported in vegetable phosphatides[4–8].

We have now found, in addition to inositol, a combined disaccharide and serine in kephalin from groundnut oil. This material is an alcohol-insoluble powder which comprises some 60 per cent of the total phosphatides of groundnut lecithin. It gives a positive Molisch test, but does not reduce Fehling's solution until after hydrolysis with mineral acid. Analysis gives: C, 57·9; H, 9·1; N, 1·2; P, 2·9; amino-N (van Slyke), 0·58 per cent; acetyl value, calculated as OH, 9·0 per cent; calculated values for (I) (di-oleyl), for comparison, are C, 66·0; H, 10·7; N, 1·88; P, 4·16 per cent.

Hydrolysis of this powder for twelve hours with boiling $N/100$ sulphuric acid and evaporation of the neutralized (baryta) and filtered hydrolysate yielded a syrup, which was found by paper chromatography (*n*-butanol) to contain a disaccharide and a small amount of arabinose; and, after further hydrolysis of the syrup with $2N$ sulphuric acid, galactose and an increased amount of arabinose, were identified by the same method. Pending the isolation and characterization of the disaccharide, we assume that the presence of arabinose in the first hydrolysate indicates that it is a galacto-arabinoside.

The basic constituents have been investigated by the chromatographic method used by Chargaff *et al.*[9] in their study of tissue phosphatides, and we find both ethanolamine and serine present, this being, so far as we are aware, the first time that the latter has been reported in a vegetable phosphatide. We also noted on our chromatogram, as did Chargaff, the presence of a slower-moving substance, which responded to the ninhydrin test. This we have identified chromatographically as the phosphate ester of ethanolamine. Choline was not present on our chromatogram.

Inositol was detected both chromatographically and by the Scherer test, after hydrolysis of our starting material with $2N$ sulphuric acid in a sealed tube at 100° for twelve hours. In a private communication to one of us (H. H. H.), Dr. D. W. Woolley stated that a sample of groundnut phosphatides supplied by Messrs. J. Bibby and Sons, Ltd., contained some 5 per cent of inositol.

Our results thus indicate that groundnut kephalin is mainly a mixture of phosphatidyl-ethanolamine and -serine, each combined with a galacto-arabinoside or inositol or possibly to some extent with both, since both the phosphate hydroxyl and the free amino-group are possible points of attachment. The most noticeable difference in the analytical data of the inositol compounds of Folch and Woolley and that of our kephalin is that the whole of their nitrogen is present as free amine, whereas only half of ours is free. This suggests that the sugar may be attached to the amino-group, whereas the inositol, as would be expected, is attached to the phosphate group.

We are grateful to Dr. J. K. N. Jones for advice on sugar chromatography, to Mr. C. L. Bibby for his interest and helpful criticism, and to Messrs. J. Bibby and Sons, Ltd., for a grant which greatly assisted this work.

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[1] Folch, J., and Schneider, H. A., *J. Biol. Chem.*, **137**, 51 (1941).
[2] Folch, J., and Woolley, D. W., *J. Biol. Chem.*, **142**, 963 (1942).
[3] Folch, J., *J. Biol. Chem.*, **146**, 35 (1942).
[4] Folch-Pi, J., *Biochem. Rev.*, **17**, 147 (1948).
[5] cf. Gray, E. Le B., *J. Biol. Chem.*, **136**, 167 (1940).
[6] Winterstein, E., and Hiestand, O., *Z. physiol. Chem.*, **47**, 496 (1906).
[7] McKinney, R. S., Jamieson, G. S., and Holton, W. B., *Oil and Soap*, **14**, 126 (1937).
[8] Woolley, D. W., *J. Biol. Chem.*, **147**, 581 (1943).
[9] Chargaff, E., Levene, C., and Green, C., *J. Biol. Chem.*, **175**, 67 (1948).

β-Aroylpropionic Acids

When a solution of phenol and succinic anhydride in acetylene tetrachloride was cooled in a freezing mixture and treated slowly with aluminium chloride, at such a rate that the temperature of the reactants did not exceed 0°, and the reaction completed as stated by Mitter and Shyamakanta[1], then the product was found to be a mixture of β-(*o*-hydroxybenzoyl)propionic acid (m.p. 145°) and β-(*p*-hydroxybenzoyl)propionic acid (m.p. 160°), in which the *o*-hydroxy-acid was predominant. This is contrary to the statement of Mitter and Shyamakanta[1], that the only product of the reaction is the *o*-hydroxy-acid.

The separation of the two acids was carried out either by (i) fractional crystallization from water, when the *o*-hydroxy-acid, being less soluble, crystallizes out first, leaving the *p*-hydroxy-acid in solution, or (ii) by making use of the fact that the *o*-hydroxy-acid is not easily etherified with dimethyl sulphate; the mixture of acids was, therefore, treated with dimethyl sulphate in boiling 20 per cent sodium hydroxide solution, and the precipitated acids were

esterified with hydrogen chloride gas and methyl alcohol. The esters formed were extracted with alkali; the insoluble fraction gave on hydrolysis β-(*p*-methoxybenzoyl)propionic acid (m.p. 151°), undepressed on admixture with an authentic specimen)[1]. The phenolic fraction was hydrolysed to β-(*o*-hydroxybenzoyl)propionic acid. This acid, however, was easily methylated, by refluxing its acetone solution with methyl iodide in presence of dry potassium carbonate[2], to methyl β-(*o*-methoxybenzoyl)propionate, which was hydrolysed to β-(*o*-methoxybenzoyl)propionic acid (m.p. 100°).

Reduction of β-(*o*-hydroxybenzoyl)propionic acid with amalgamated zinc and hydrochloric acid gave γ-(*o*-hydroxyphenyl)butyric acid (m.p. 67°)[1], which was methylated with methyl iodide and potassium carbonate in acetone solution to methyl γ-(*o*-methoxyphenyl)butyrate (b.p. 122–124°/3 mm.). When this was hydrolysed with 10 per cent alcoholic potassium hydroxide and the product distilled in vacuum (b.p. 165–168°/2 mm.), it gave γ-(*o*-methoxyphenyl)butyric acid (m.p. 41–42°)[3]. The latter acid could also be prepared by the reduction of β-(*o*-methoxybenzoyl)propionic acid with Clemmensen's modified method[4].

Attempts to prepare β-(*o*-methoxybenzoyl)propionic acid by the action of *o*-anisylmagnesium bromide on a boiling benzene solution of succinic anhydride gave a product of melting point 178°, which was found to be identical with the product obtained by the action of *o*-anisylmagnesium bromide on a boiling benzene solution of β-(*o*-methoxybenzoyl)propionic acid. It was insoluble in cold potassium hydroxide solution, and dissolved only on refluxing for a long time. On acidifying the ice-cold alkaline solution, an acid was precipitated which was freely soluble in potassium carbonate solution. However, this acid was partially converted into the original product on boiling with dilute hydrochloric acid. This property, besides the results of analyses, showed that the product is a lactone, most probably that of γ : γ-di-(*o*-anisyl)-γ-hydroxybutyric acid. Its exact constitution as well as the mechanism of its formation are now under investigation.

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[1] Mitter, P. C., and Shyamakanta, De, *J. Ind. Chem. Soc.*, **16**, 35 (1939).
[2] cf. Baddar, F. G., *J. Chem. Soc.*, 224 (1947).
[3] Lockett, J., and Short, W. F., *J. Chem. Soc.*, 783 (1939), give m.p. 39–39·5°.
[4] Martin, E. L., *J. Amer. Chem. Soc.*, **58**, 1438 (1936).

Products of the Hydrolysis of Wool Keratin by Papain

The study of the action of enzymes on proteins is engaging the attention of a number of workers. The present communication describes the results of an investigation into the products formed when papain acts on wool keratin. This reaction has been described previously[1]; but little is known about the hydrolysis products.

In order to investigate the peptides formed in the reaction, a 56's quality virgin wool was treated with 2 per cent papain (calculated on the weight of the wool) for 3½ hr. at 65° C. in 1 per cent sodium bisulphite solution. These conditions, which are much more drastic than those used in commercial treatment to impart felting resistance, break up the wool fibres into cortical cells which are readily removed by centrifuging. When the supernatant solution containing the peptides formed in the reaction is acidified to *p*H 4 a gelatinous precipitate, which forms a hard horn-like mass on drying, separates out. This polypeptide contains a wide variety of amino-acids, but its cystine content is much lower than that of the cortical cells formed simultaneously. The X-ray diffraction diagram, for which I am indebted to Dr. T. C. Tranter, showed that this peptide had a disordered β-keratin type of structure. It would seem to be of fairly long chain-length; but whether it forms an intermediate in the reaction is not yet known.

Those peptides which remain in solution after acidification constitute the greater part of the material going into solution during the papain digestion, and have a mean chain-length of five amino-acid residues. They were examined by chromatography on paper. A two-dimensional chromatogram in collidine and phenol-ammonia showed the presence of a strong glycine 'spot' but no appreciable amount of other free amino-acids. This liberation of glycine may indicate that it is split off from some special position in the wool keratin molecule, and, in fact, glycine has been found to terminate some of the peptide chains of wool[2,3]. An alternative explanation is that peptide bonds on both sides of glycine residues in the middle of the chain are split much more rapidly than other peptide bonds, glycine having no side chain in such a spacial arrangement that it can hinder the approach of the enzyme[4].

A greater degree of separation of the low molecular-weight peptides was achieved by running one-dimensional chromatograms in other solvents such as *n*-butanol. Several 'spots' were observed which tended to 'tail' into each other. The amino-acids present in the various peptide 'spots' were investigated by elution from the paper and hydrolysis. Although the investigation is not yet complete, differences in amino-acid composition between the various peptides have been observed. It is probable that each 'spot' contained a mixture of peptides, and that there are a large number of peptides of differing degrees of complexity present in the papain hydrolysate of wool, of which only a partial separation has so far been achieved.

The complex nature of the mixture of peptides is also indicated by end-group determinations by Sanger's method[5], using buffered columns to separate the 2 : 4 dinitrophenylamino-acids[6]. The following terminal amino-acids, that is, those carrying free amino-groups, were found among these peptides: leucine + *iso*leucine, valine, alanine, glycine, threonine, serine, glutamic acid and aspartic acid. No appreciable quantities of free amino-groups belonging to the basic amino-acids arginine, lysine and histidine were detected, however. The enzyme thus liberates a large number of different amino-groups from the peptide linkages, and in this respect does not exhibit a very high degree of specificity in its action on wool. Bergmann and co-workers[4,7] considered that papain was able to hydrolyse the most varied types of peptide bonds, though at widely different velocities. These conclusions, obtained in studies on relatively few synthetic peptides, may not necessarily be applicable to proteins.

I am indebted to the Council of the Wool Industries Research Association for permission to publish this

note, and to G. R. Lee for assistance with the experimental work.

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[1] Middlebrook, W. R., and Phillips, H., *J. Soc. Dyers Col.*, **57**, 137 (1941).
[2] Blackburn, S. (unpublished observations).
[3] Middlebrook, W. R., *Nature*, **164**, 501 (1949).
[4] Lergmann, M., and Fruton, J. S., *J. Biol. Chem.*, **117**, 189 (1937).
[5] Sanger, F., *Biochem. J.*, **39**, 507 (1945).
[6] Blackburn, S., *Nature*, **163**, 955 (1949); *Biochem. J.*, **45**, 579 (1949).
[7] Bergmann, M., Zervas, L., and Fruton, J. S., *J. Biol. Chem.*, **115**, 593 (1936).

Low-Temperature Decomposition of Rocks, Ores and Minerals by Sodium Peroxide using Platinum Vessels

RECENT work at the Dominion Laboratory on the decomposition and analysis of refractory minerals has led to the belief that the lower the temperature of decomposition using the common fluxes the more soluble are the products in water or acids. The time for complete decomposition at the correct temperature for the flux appeared to be only a few minutes or even less.

The effectiveness of sodium peroxide as a decomposing agent is well known; but its usefulness has been limited by its corrosive action on the vessel used during prolonged heating at high temperatures. Experiments have shown, however, that such prolonged heating and high temperatures are unnecessary with this reagent, and that many refractory minerals can be effectively decomposed by heating with sodium peroxide for a few minutes only at a temperature below 500° C. In these experiments a platinum crucible was used, and after repeated decompositions no attack on the platinum could be detected.

The finely powdered mineral, ground to pass a 240 B.S.S. sieve, was mixed with sodium peroxide in the ratio of 1 : 4 in a platinum crucible and covered with a light layer of peroxide. The crucible was placed for seven minutes in a muffle furnace held at a temperature of 480° ± 20° C. On removal, the crucible was cooled quickly and the readily detachable sintered cake dropped into 50–100 ml. of cold water. Rapid and complete disintegration took place either in the alkaline solution so formed or on acidifying by the rapid addition of acid to the cold suspension.

The method outlined appears to be applicable to a wide variety of inorganic compounds and should be particularly useful in treating some minerals hitherto regarded as difficult to decompose. So far it has been used successfully to decompose the following: chrome refractory, bauxite, flint clay, zircon, chromite, wolfram, scheelite, rutile, magnetite, garnet, cassiterotantalite, titanite, beryl, black ilmenitic sand, glass sand, greensand, gypsum, celestine, baryta, feldspar, basalt, rhyolite, trachyte, andesite and osmiridium. The last-named required four successive treatments before complete solution was attained. Caution is indicated in heating sulphides with sodium peroxide, as the heat of reaction may result in temperatures high enough to cause attack on the vessel used.

The mechanism of the reaction with sodium peroxide and its application to the assay of ores, inorganic analysis, the preparation of salts and the possible recovery of metals from their ores are being investigated further.

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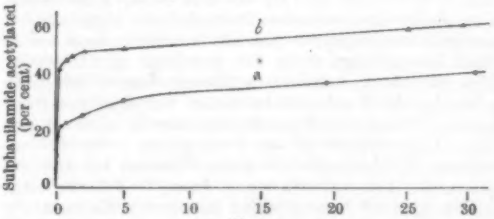
Acetylation of Sulphanilamide by Acetyl Metaphosphate

THE problem regarding the nature of the reactive, intermediate C_2-compound in acetate metabolism is not clear at present. With regard to biological acetylations, it is evident, especially from Lipmann's[1] work, that a strongly acetylating substance is formed in an enzymatic reaction between acetate and adenosine triphosphate. According to Lipmann's recent papers[2], this intermediate is different from acetyl phosphate, but is transformed to acetyl phosphate in acid solution at room temperature. We have considered the possibility that the primary product in the phosphate transfer from adenosine triphosphate to an acceptor might be a metaphosphate compound. Some chemical and biological points in favour of this hypothesis will be discussed elsewhere.

Lipmann[3] has shown that, in the enzymatic acetylation of sulphanilamide, acetyl phosphate is not able to replace adenosine triphosphate + acetate as acetylating agent. According to the above hypothesis, acetyl metaphosphate would be the primary product in the reaction between adenosine triphosphate and acetate. We have therefore studied the analogous non-enzymatic reaction with acetyl metaphosphate as acetyl donor, and observed a rapid acetylation of sulphanilamide.

Acetyl metaphosphate was synthetized by adding excess of silver metaphosphate to a solution of acetyl chloride (usually 1–5 gm.) in 25 ml. dioxane at 0° C. After shaking the mixture for about three days, no chlorine is found in the solution. After centrifugation, the solution is yellow to brown or black, depending on the amount of acetyl chloride used. Attempts to isolate acetyl metaphosphate by precipitation or by evaporation of the solvent resulted in the formation of dark products. Therefore the solution was used as such. Analysis of the solution gave values slightly higher for acetyl than for phosphorus.

1 ml. of the dioxane solution was mixed with 20 ml. of an aqueous solution of sulphanilamide in *M*/15 phosphate buffer, *p*H 7·5, at room temperature. The degree of acetylation was determined by coupling the non-acetylated diazotized sulphanilamide with N-ethyl α-naphthylamine (kindly supplied by H. Lundbeck and Co., Copenhagen) and photometric analysis according to Frisk[4].



Curve *a*: $2·8 \times 10^{-3}$ *M* sulphanilamide; curve *b*: $2·8 \times 10^{-4}$ *M* sulphanilamide

The results of two experiments are seen in the accompanying graph. In both experiments, the concentration of acetyl metaphosphate (according to analysis for phosphorus) in the reaction mixture was 4×10^{-3} molar. The two curves correspond to different sulphanilamide concentrations. The rate of acetylation is seen to be rapid in the first 15 min. or so after mixing, after which there is a period of much slower acetylation. We consider the first period as representing acetylation by acetyl metaphosphate. The later period may represent acetylation by acetyl pyrophosphate, or by diacetyl pyrophosphate formed in the solution by a reaction between acetyl metaphosphate and water.

These results are compatible with the hypothesis of acetyl metaphosphate being the natural intermediate in the reaction between adenosine triphosphate and acetate. A better proof of this hypothesis can be obtained by investigations with the acetylating enzyme system and acetyl metaphosphate. Experiments of this kind are in progress.

We are indebted to Prof. K. Linderstrøm-Lang for his interest in this work.

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[1] Lipmann, F., "Adv. in Enzymol.", **6**, 231 (1946).
[2] Kaplan, N. O., and Lipmann, F., *J. Biol. Chem.*, **178**, 459 (1948).
[3] Lipmann, F., *J. Biol. Chem.*, **160**, 173 (1945).
[4] Frisk, A. R., *Acta Med. Scand.*, Supp. 142, 75 (1943).

Mucilage of *Dumontia incrassata*

THE red alga *Dilsea edulis* (natural order, Cryptonemiales; family, Dumontiaceæ) has recently been shown to yield a mucilage which consists of a galactan sulphuric ester containing two SO_3H groups and one uronic acid lactone residue associated with nine galactose residues. The linkages of the galactose residues are predominantly 1 : 3; but about one in every five is linked 1 : 4 [1,2].

We have now examined the mucilage of *Dumontia incrassata*, a more commonly occurring member of the family Dumontiaceæ[3]. This mucilage had already been extracted by Kylin[4] and shown by him to contain galactose.

According to Kylin, the mucilage of *D. incrassata* is extracted in large quantities on standing in water for several days at room temperature. We have found that the plant rots easily when an attempt is made to dry it in the air, or when it is left in water, and that the most satisfactory method of extraction is to immerse the freshly gathered plants in 2 per cent hydrochloric acid for about a week. After filtration of the viscid solution through linen bags, alcohol precipitates the polysaccharide as a white mass somewhat less stringy than the mucilage of *D. edulis*. Like the latter, it dries to a fibrous mass which gives a highly viscid solution in water, but does not form a gel. The yield of crude mucilage is about 1 per cent of the weight of the fresh plant. By dialysis against $N/2$ hydrochloric acid, followed by distilled water, the ash content was reduced to 2·5 per cent.

The product thus purified has a specific rotatory power (corrected for ash and moisture) of + 53 (cf. + 47·2 for the *Dilsea* mucilage[1]). A 1 per cent solution has a *p*H of about 2. Aqueous solutions give, with ferric chloride, a reddish-brown precipitate, which, unlike the corresponding precipitate of the *Dilsea* mucilage[1], is insoluble in dilute acetic acid, though soluble in mineral acids.

The mucilage contains no sugar other than galactose, and it contains esterified sulphuric acid and a uronic acid residue, which, like that of the *Dilsea* mucilage, appears to be in the form of a lactone.

By oxidation with periodic acid and estimation of the glyoxal in the oxidized product as osazone[1], it was established that about five galactose units were unattacked, and therefore linked 1 : 3, for every unit oxidized. The linkages of these oxidized units have not so far been determined by methylation experiments; but it is most probable that they would prove to be 1 : 4, as in the *Dilsea* mucilage.

So far, the mucilage appears to be identical with that from *D. edulis*. Determinations of uronic acid and of esterified sulphuric acid, however, showed that the mucilage of *D. incrassata* contains *four* SO_3H groups and one uronic acid residue associated with nine galactose residues, giving the formula $[(C_6H_{10}O_5)_9(C_6H_4O_5)(SO_3)_4]_n$.

Algal galactan sulphuric esters are now known in which the ratio sulphate radical to galactose radical (plus uronic acid when present) is 1 : 1 (*Chondrus crispus*[5] and *Irideæ laminarioides*[6]), 2 : 5 (*D. incrassata*), 1 : 5 (*D. edulis*), 1 : 42 (*Gelidium crinale*[7]), 1 : 45 (*Gracilaria confervoides*[7]) and 1 : 55 (*Gelidium latifolium*[8]).

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[1] Barry and Dillon, *Proc. Roy. Irish Acad.*, B, **50**, 349 (1945).
[2] Dillon and McKenna, *Proc. Roy. Irish Acad.* (in the press).
[3] Levring, *Lunds Universitets Arsskrift*, **33**, 8, 98 (1937).
[4] Kylin, *Z. physiol. Chem.*, **83**, 195 (1913).
[5] Haas and Russell-Wells, *Biochem. J.*, **23**, 425 (1929).
[6] Hassid, *J. Amer. Chem. Soc.*, **55**, 4163 (1935); **57**, 2046 (1937).
[7] Percival, *Nature*, **154**, 673 (1944).
[8] Barry and Dillon, *Chem. and Indust.*, **63**, 167 (1944).

Oxidation of Ascorbic Acid by Plant Extracts

THAT the catalytic agency responsible for vitamin C oxidation in plant extracts is a specific copper-protein enzyme has been shown by several workers[1]. There is, however, disagreement as to whether the oxidase activity is exerted by this complex, or by the ionized copper from it. Active preparations of artificial oxidases, with ionic copper as the responsible constituent, have been reported[2]. On the other hand, purified preparations of the enzyme have been found to oxidize ascorbic acid many times faster than an equivalent quantity of cupric ion[3].

The following observations, made in the course of investigations on the biogenesis of vitamin C in plants, provide a further distinction between the oxidations caused by the oxidase and by the cupric ion:

(1) There was no oxidase activity in extracts of seeds soaked overnight of legumes such as mung (*Phaseolus radiatus*), masoor (*Lens esculenta*), black pea (*Pisum arvense*) and matki (*Phaseolus aconitifolius*). Only a slight activity was noticeable on the second day of germination following this preliminary period of soaking. Activity increased with the subsequent progress of germination.

(2) Extracts of seeds soaked overnight, when added to an ascorbic acid oxidase preparation from cucumber rind, caused a nearly two-fold enhancement in its capacity to oxidize the vitamin. This characteristic of seed extracts was thermostable and diminished rapidly with germination, being absent on or after the fourth day.

(3) In contrast, the extract protected ascorbic acid against oxidation by cupric ion; this was shown even during progressive germination. Thus, in one instance, extract from seeds soaked overnight inhibited completely the oxidative action of a 0·01 per cent solution of copper sulphate; corresponding inhibitions exerted on the fourth and sixth days of germination were 35·1 and 29·5 per cent respectively. This effect was caused by both heated and unheated (that is, in presence of oxidase) extracts. Similar inhibition of the action of cupric ions on ascorbic acid by heated plant extracts has been reported earlier[4].

(4) The degree of inhibition reported in (3) was the same when the copper solution was heated with the extract and then allowed to oxidize ascorbic acid, as when it oxidized the vitamin in presence of previously heated extract.

(5) Oxidase activity of extracts from seedlings which had been germinated for four to five days, freed from cupric ions by dialysis but not purified, was about five times greater than that caused by the copper present in it.

Fuller details, together with a postulated mechanism whereby ionic copper, in presence of a specific agency, constitutes the ascorbic acid oxidase of plant extracts, and which would explain the foregoing and related observations, will be published elsewhere.

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[1] Silverblatt, E., and King, C. G., *Enzymologia*, **4**, 222 (1938). Ramasarma, G. B., Datta, N., and Doctor, N., *Enzymologia*, **8**, 108 (1940). Diemair, W., and Zerban, K., *Biochem. Z.*, **316**, 189 (1943). Powers, W. H., Lewis, H., and Dawson, C. R., *J. Gen. Physiol.*, **27**, 167 (1944).

[2] Stotz, E., Harrer, C. J., and King, C. G., *J. Biol. Chem.*, **119**, 511 (1937); **122**, 407 (1938). Lampitt, L. H., and Clayson, D. H. F., *Biochem. J.*, **39**, xv (1945).

[3] Lovett-Janison, P. L., and Nelson, J. M., *J. Amer. Chem. Soc.*, **62**, 1409 (1940).

[4] Krishnamurthy, P. V., and Giri, K. V., *J. Ind. Chem. Soc.*, **18**, 7, 191 (1941); *Ind. J. Med. Res.*, **29**, 71 (1941).

An Unstable Lattice in Silk Fibroin

The filament of the silkworm *Bombyx mori* gives the well-known X-ray fibre diagram[1], which can also be obtained by stretching the silk-gland taken from the animal[2].

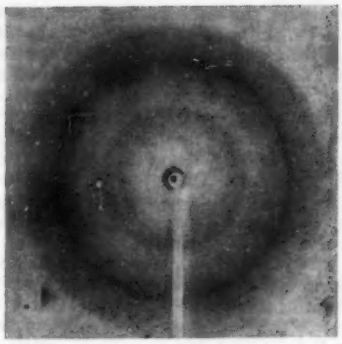
Table 1

D	Intensity
7·5	moderate
4·9	weak
4·5	strong plus
4·0	very weak
3·6	strong
3·1	strong
2·6	weak
2·4	rather weak

Table 2

Silk I	*F*-Actin
7·5	7·9 strong 6·8
4·5	4·5 strong 4·2 moderate
3·60	3·60 moderate
3·10	(3·10 very weak)

R. Brill[3] discovered that the fibroin in the living silkworm gives only completely amorphous diagrams which are, however, converted into Debye–Scherrer diagrams if the gland is air-dried. No further details



about these diagrams were given. Aiming at a more detailed study of the crystallization process, we have repeated his experiments. It is remarkable that the X-ray photographs obtained by drying the native fibroin present an exceedingly discrete powder diagram (see photograph and Table 1) which does not agree quantitatively with the well-known diagram, neither with regard to the net-plane distances *D*, nor where the intensities are concerned. The net-plane distances are very similar to the smaller ones of actin[4], as shown by Table 2. Hence, the fibroin, which is present in the native silk gland in a dispersed state, forms crystals on drying. The extremely sharp reflexions suggest that the crystals form without interference and are much bigger than those of the spun silk fibroin.

One is tempted to interpret these results in accordance with Astbury[5], who assumes that fibre proteins form by aggregation of 'monomer' particles, and that a following deformation may disturb the original high regularity, causing the polypeptide chains to unfold.

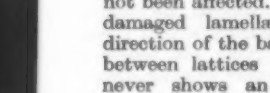
It has been found that a transition to the well-known β-diagram occurs very easily, and it is due to this fact that it has unfortunately been impossible, so far, to achieve an orientation of the primarily formed crystallites in order to measure the fibre period.

We suggest denoting the newly found lattice type as 'silk fibroin from *Bombyx mori*, type 1', as contrasted to the well-known 'type 2'. We may also mention that 'silk 1', after swelling in concentrated formic acid, gives a typical amorphous diagram with two intense, broad interference rings. These correspond approximately to the net-plane distances 7 A. (medium) and 3·5 A. (strong). A final explanation of this diagram is, of course, not yet possible; however, it appears reasonable to consider these distances as the first and second order of a distance characteristic for the single amino-acid (side-chain distance).

On drying the sample, the unchanged 'diagram 1' is again obtained. After any stretching of preparations of type 1—which is, of course, only possible after swelling, for example, in formic acid—the well-known 'diagram 2' is obtained, even if the extension keeps within the elastic region (15 per cent stretching).

At the first orientation, the flat micelles of 'lattice 2' turn—as known—parallel to the plane of the film. An X-ray photograph perpendicular to the plane of the micelles shows the remarkable effect of a faint double structure, namely, with the chain directions parallel and perpendicular to the direction of stretch-

ing. Considering the mechanism of the stretching of a micellar network, such an effect at lower degrees of stretching seems understandable. Higher degrees of stretching easily lead to the well-known higher orientation, with good alignment of both axes of the micellar planes. On swelling preparations of 'lattice 2' in formic acid, the crystal reflexions disappear, as already established by Meyer and Mark[6]. On drying, 'lattice 2' reappears. Once the 'lattice 2' had been reached, it has, so far, been absolutely impossible to reproduce the original 'diagram 1'. When the native silk fibroin is dissolved in 10 per cent sodium hydroxide and precipitated with ammonium sulphate, one obtains a diagram showing only one strong reflexion which, within the range of experimental error, is equivalent to the net-plane distance A_3 of 'lattice 2', corresponding to 4·3 A. This value, which corresponds to the backbone distance, has obviously not been affected. One is tempted to assume greatly damaged lamellæ with hydrogen bonds in the direction of the backbone. A fundamental difference between lattices '1' and '2' is also that 'type 1' never shows an additional absorption band at 4,000 mm.$^{-1}$, which appears only in type '2'[7]. The band has been ascribed to the formation of C=N groups within the peptide chains, by transition of



The experiments are being continued. We are much indebted to J. O. Fixl for valuable assistance and careful measurements.

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[1] Brill, R., *Liebigs Ann.*, **434**, 204 (1923).
[2] Kratky, O., *Z. phys. Chem.*, (B), **5**, 297 (1929). Kratky, O., and Kuriyama, S., *Z. phys. Chem.*, (B), **11**, 363 (1931).
[3] Brill, R., *Naturwiss.*, **18**, 622 (1930).
[4] Astbury, W. T., Perry, S. V., Reed, R., and Spark, L. C., *Biochim. et Biophys. Acta*, **1**, 379 (1947).
[5] Astbury, W. T., Dickinson, S., and Bailey, K., *Biochem. J.*, **29**, 2351 (1935).
[6] Meyer, K. H., and Mark, H., *Ber. deutsch. chem. Ges.*, **61**, 1932 (1928).
[7] Schauenstein, E., Fixl, J. O., and Kratky, O., *Mh. Chem.*, **80**, 143 (1949). Schauenstein, E., *Mh. Chem.*, **80**, 820 (1949).

Liberation of Heparin and Histamine by *d*-Tubocurarine

It is well known that curare[1] and tubocurarine[2] liberate histamine from skeletal muscle. I have perfused the isolated lungs of the guinea pig as described by Feldberg and Kellaway[3], and find that tubocurarine chloride (B. W. and Co.) in doses of 1–10 mgm. liberates histamine, the output of which resembles in magnitude and time that caused by injury by peptone or anaphylaxis.

When tubocurarine (0·25–15 mgm.) is injected into the portal vein of the dog under chloralose, in about 20 sec. there is a sharp rise of portal pressure with a fall in systemic arterial and venous pressures (see trace). Systemic intravenous injection causes a fall of arterial and venous pressures; the portal pressure also falls, interrupted by a small transient rise only. This indicates that the rise of portal pressure is

mainly due to an action of the drug within the liver itself. That this action is one of histamine liberation is shown by the antagonism of benadryl to small doses of tubocurarine given intra-portally and by the detectable loss of liver histamine with larger doses. The smallest dose (0·25 mgm.) caused a rise of portal pressure greater than that caused by the intraportal injection of 50 μgm. of histamine-acid phosphate, and with large doses, although no direct match was possible, the effect was probably equivalent to that of several milligrams of histamine. The loss of histamine, estimated by comparing the content of two pieces of liver removed before and after injection, varied from no detectable loss to a loss of 44 per cent. Thus in one experiment, in which 3 mgm. of tubocurarine was injected intra-portally, the histamine content fell from 55 to 36 μgm. per gm., representing a total loss of some 5·7 mgm.

On the other hand, when the isolated liver is perfused with Tyrode or heparinized blood containing tubocurarine, no more than a few micrograms of histamine appear in the perfusate, and no loss from the liver is detectable. This resembles peptone and anaphylactic injury in that large quantities of histamine are released *in vivo* but not from the perfused liver[4]. This similarity suggested the possibility that heparin was liberated as with peptone and anaphylaxis, and this was clearly shown to be so. Following the intraportal injection of 4–15 mgm., arterial blood withdrawn within 20 min. after injection had not coagulated 24 hr. later in three experiments, and in a fourth experiment the clotting-time had increased from 5 to 60 min. The blood could be promptly clotted by thrombin or protamine. A typical titration[5] showed that blood, taken 4, 10 and 22 min. after the injection of 10 mgm. of tubocurarine, required the addition of 0·02, 0·015 and 0·02 mgm./0·5 c.c. blood of protamine respectively to reduce the clotting-time to its lowest value.

Recently it has been shown[6] that certain organic bases the depressor effects of which resemble those of a very large group of compounds, including tubocurarine, liberate histamine and heparin, and it is considered that the liver is the main site of action in the dog. My results show that tubocurarine liberates heparin, and direct attention to similarities between its action and peptone and anaphylactic injury. However, in the dog, the results of systemic intravenous

injection of the drug indicate that the liver is not the main site of histamine liberation in these circumstances.

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[1] Alam, M., Anrep, G. V., Barsoum, G. S., Talaat, M., and Wieninger, E., *J. Physiol.*, **95**, 148 (1939).
[2] Schild, H. O., and Gregory, R. A., Proc. XVII Int. Physiol. Congr., 288 (1947).
[3] Feldberg, W., and Kellaway, C. H., *J. Physiol.*, **90**, 259 (1937).
[4] Kellaway, C. H., *Edin. Med. J.*, **54**, 333 (1947).
[5] Jacques, L. B., and Waters, E. T., *J. Physiol.*, **99**, 454 (1941).
[6] MacIntosh, F. C., and Paton, W. D. M., *J. Physiol.*, **109**, 140 (1949).

Quantitative Determination of Dehydro*iso*-androsterone in Pure Solutions and in Urine Extracts

2 ml. of pure concentrated sulphuric acid are added drop by drop to 0·1 ml. of a solution of dehydro*iso*-androsterone in ethyl alcohol or of an extract containing 5–50 γ of that substance in a test tube. The mixture is heated to 60° C. for 25 min. and then cooled in ice water. The chilling is discontinued, and 5 ml. ethyl ether (water- and peroxide-free) are added slowly while the mixture is thoroughly stirred with a glass rod.

As a result of the above procedure, dehydro*iso*-androsterone gives a blue colour which, when measured in a Pulfrich photometer, has maximal absorption at 570 mμ. With an extract or an eluate, the maximal colour intensity is first obtained after an additional 2 min. heating to 100° C. The extinction values at 570 mμ for pure solutions are proportional to the concentration of dehydro*iso*androsterone up to 60–70 γ. In cases where 0·1 ml. of extract (20 ml. extract corresponds to the amount of urine excreted in 24 hr.) gives, by the method described above, a blue-violet reaction colour (E 530/E 570 < 0·95), one can say with certainty that the patient in question is suffering from some hormonal disorder which is evidenced by an increased excretion of 3β-hydroxy-17-ketosteroids.

In order to obtain a more exact determination of the amount of dehydro*iso*androsterone in urine extracts, it is necessary to carry out first a chromatographic fractionation of, for example, 2 ml. of the extract, and to work out a curve for the correction of the extinction values obtained. Such a curve has been drawn by determining known quantities of dehydro*iso*androsterone which have been added to different extracts and eluates in varying amounts (3–50 γ). Of the different quantities used (unknown to the analyst) 85–110 per cent has been found.

Determinations on many urine extracts have given values from 147 mgm. per 24 hr. (virilizing ovarian tumour with metastases) to 0·2 mgm. (normal cases) of dehydro*iso*androsterone. In a four-year-old girl with pubertas præcox, we found 7·4 mgm. dehydro-*iso*androsterone, which corresponded to 55·7 per cent of the total excretion of 17-ketosteroids. In several cases of hirsutism with hypertension and in some cases of Cushing's syndrome, we have demonstrated amounts of dehydro*iso*androsterone corresponding to 14–30 per cent of the total neutral 17-ketosteroid excretion. In two cases of adrenocortical adenoma (♀), we have found a total of approximately 20 mgm. neutral 17-ketosteroids; 22–28 per cent thereof gave the dehydro*iso*androsterone reaction. In one case of adrenocortical carcinoma (♀), 41 mgm. of 17-ketosteroids were found and 54·4 per cent was determined as dehydro-*iso*androsterone.

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Rotational Slip—a New Deformation Process in Crystals

During the past three years I have collected evidence (now being published, submitted July 1949) that a new kind of slip is common in crystals. It is proposed to call it 'rotational slip', and it can be defined as the slipping of one part of a crystal on a neighbouring part, so that the two atomic sheets which slide over one another are densely populated planes, as in translational slip, but rotationally displaced about an axis normal to their plane (with or without simultaneous translational displacement) to one of a series of definable new positions where metastable equilibrium can occur. There is then only a two-dimensionally periodic partial fitting together of the two crystal parts. Neither the occurrence nor the nature of such slip has been clearly demonstrated hitherto.

It is now shown that for rectangular plane lattices (including centred-rectangular, that is, rhombus and hexagonal) an azimuthal displacement δ corresponds to a high order of density of coincident points in the contact plane, if $\tan \delta/2 = v_1 b/u_1 a$, or $u_2 a/v_2 b$, where u_1 and v_1 or u_2 and v_2 are relatively small integers. In the first case, the $[u_1 v_1]$ and $[u_1 \bar{v}_1]$ lattice rows then coincide along the direction bisecting the two a-directions, and in the second case $[u_2 v_2]$ and $[\bar{u}_2 v_2]$ coincide along the bisector of the two b directions. If both conditions are fulfilled simultaneously, $u_1 u_2 / v_1 v_2 = b^2/a^2$. If also v_1 and u_2 are unity, the lattice of coincidence points is then similar to the plane lattice of either of the rotated sheets but enlarged in the ratio cosec $\delta/2$ and rotated by 90° relative to the directions bisecting the a- and the b-directions; otherwise it has these axes further enlarged in the ratios v_1 and u_2 respectively. The main predicted angles δ were clearly recognized in a ball-bearing model simulating atomic packing, when one layer was rotated over another, and the 'moiré' pattern of two superposed perforated zinc sheets illustrated well the variation in size of the coincidence pattern with δ.

Exactly the same set of azimuths δ corresponds to the optimum fitting of two crystals (of the same species) which are rotationally displaced about an axis c normal to the common plane (a,b), though in contact not on this plane, superposed, but on a plane $(v_1 u_1 0)$ or $(v_1 \bar{u}_1 0)$ (or alternatively $(v_2 u_2 0)$ or $(v_2 \bar{u}_2 0)$), that is, laterally adjacent crystals. Simultaneous lateral and superposed contact of two such crystals can also therefore occur. Examples of this lateral fitting are well shown in 'polycrystal' bubble-raft photographs published by Dyson[1], with the corresponding optical diffraction patterns.

From electron-diffraction photographs from cadmium iodide, graphite, copper, silver, etc., many recorded about 1936, and from others obtained in this laboratory during 1933–49 [2], and also elsewhere[3], many cases are illustrated of spot patterns from a wide variety of crystals, showing close agreement with the above δ-values between successive members

of triplet, quadruplet or higher groupings of crystals having a common direction of orientation (usually relative to the substrate collodion film or the specimen surface). The features of these diffraction-spot groupings (secondary-scattering effects indicating crystal superposition; equidistant spots of the group; 'tadpole-shaped' arcs), and in some cases their known origin from mechanical deformation, led to the conclusion that at least in many of the examples they were due to a coherent subdivision of crystals by rotational slip as defined above. The plane on which such slip occurred was often the plane of cleavage, to which process rotational slip is related in respect of the cohesionally strong binding of the atoms in the planes and the weaker binding between those of the adjacent superposed planes.

Macroscopic rotational slip on cleavage planes was easily shown in potassium ferrocyanide trihydrate and in gypsum, induced in a regular (microscopically) lamellar manner by couples applied tangentially by frictional grip over the whole area of the cleavage-plane surface, with the aid of a sufficient simultaneous vertical pressure which was greater in gypsum than in the ferrocyanide. Some twisted crystals (quartz, pyrites, etc.) illustrated in the literature appear to have undergone similar regular rotational slip on simple lattice planes.

It is concluded that still further examples of rotational slip, produced by directed forces applied on single crystals, occur in (1) development of 'deformation bands'[4], which are evidently initially simply the coherent subdivision of the crystal by rotational slip (note that in iron they form along {100}, which is its fracture plane, though also sometimes along {111}; and in aluminium along {100}—which is a rotational-slip plane indicated by the present results—and, as Barrett states[4], "possibly along others" also[5,6]); (2) the lattice deformation caused by unidirectional abrasion of a single-crystal surface along a direction parallel to a densely populated plane, such surface deformation often consisting of extensive rotational slip of lamellæ which are parallel to a cleavage plane or other simple plane (or, in ionic lattices, a plane or composite layer unit containing equal amounts of + and − charges), especially such planes normal to the surface. This second case is now deduced from electron-diffraction photographs from lead sulphide[7], sodium chloride[8] and magnesium oxide[9] abraded on {001} along <100>, hitherto not satisfactorily interpreted and, indeed, though apparently explicable in sodium chloride and magnesium oxide as due to flexural translational slip on {101} about the axis <010> normal to the abrasion direction, not so explicable in lead sulphide where translational slip has only been observed on {001}[8].

Finally, the observed coherence, at azimuthally preferred positions, between pre-existing crystals coming together on plane faces during their growth[10], is consistent with the existence of rotational slip as defined above, and these cases, as well as the azimuths of preferred fitting observed in rotational slip, demonstrate that epitaxial orientation of one crystal on another need not depend on having densely populated lattice rows parallel in the two crystals, or on a stepped form of crystal surface. It is suggested, further, that the stress caused when crystals grow epitaxially on a substrate crystal having different lattice dimensions is likely to give rise to rotational slip in some cases[8] and to mechanical twinning in others.

Many other properties of crystals are similarly clarified when considered in the light of the above results.

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[1] Dyson, J., *Proc. Roy. Soc.*, A, **199**, 130 (1949).
[2] For example, in Finch, G. I., and Wilman, H., *Ergeb. exakt. Naturw.*, **16**, 353 (1937), fig. 66.
[3] Hillier, J., and Baker, R. F., *J. App. Physics*, **17**, 12 (1945).
[4] Barrett, C. S., "The Structure of Metals" (New York: McGraw-Hill, 1943).
[5] For further confirmation of rotational slip in such cases see Evans, D. M., and Wilman, H., letter in *Proc. Phys. Soc.* (In the press).
[6] Heidenreich, R. D., and Shockley, W., *J. App. Physics*, **18**, 1029 (1947), and Report on the Conference (1947) on "Strength of Solids", 57 (London: Phys. Soc., 1948), suggested rotation of Al {111} translational-slip lamellæ on each other, but their electron-diffraction patterns appear to show rotational slip on {100}, thus probably 'deformation bands'.
[7] Germer, L. H., *Phys. Rev.*, **50**, 659 (1936). Beukers, M. C. F., *Rec. Trav. Chim. Pays-Bas*, **58**, 435 (1939).
[8] Raether, H., *Mitteilungen et Corrosion*, **22**, 2 (1947).
[9] Whitmore, E. J., Ph.D. thesis (London Univ., 1939).
[10] Gaubert, P., *Bull. Soc. Franc. Minéral.*, **19**, 431 (1896). Schaskolsky, M., and Schubnikow, A., *Z. Kristallogr.*, **85**, 1 (1932). Friedel, C., *Bull. Soc. Franc. Minéral.*, **56**, 262 (1933). Delcha, G., *Experientia*, **4**, 67 (1948).

New Absorption Lines in the Arc Spectrum of Aluminium

The predicted terms, in L—S coupling, of an sp^2 configuration, are $^4P, ^2D, ^2P, ^2S$. In the case of Al I (ground-term $3s^23p^2P^0_{1/2}$), values for all four terms arising from $3s3p^2$ have been reported[1]. Of these four identifications, only one—that of ^4P by Paschen[2]—seems hitherto to have been regarded as reasonably certain. The ^2S term has been located at − 3474·0 cm.$^{-1}$, on the basis of a diffuse emission line-pair found at 1936·45 A., 1932·25 A. by Selwyn[3]; he interpreted the pair as $3^2P^0_{1/2,\,3/2} - 3s3p^2\,^2S_{1/2}$, since the separation was equal to that of the ^2P ground-term. The assignment seems to have been regarded as doubtful by Paschen[2], and though quoted in the recently published Bureau of Standards term tables[1], is there shown followed by a question mark.

Plates recently taken in this laboratory have substantiated Selwyn's finding. In the spectrum of an arc in nitrogen, between a carbon anode and an aluminium bead on a carbon cathode, the line-pair specified was obtained completely reversed on the continuum extending from the common limit of the S- and D-series of the simple spectrum, under conditions in which these series lines also showed heavy reversal. Afterwards, a direct absorption experiment, using aluminium vaporized in a carbon-tube furnace, with the hydrogen continuum as background, showed Selwyn's line pair in absorption. This, taken together with the fact that the separation of the lines is that of the ground-term components, is conclusive. Yet a further point is that the placing of the term agrees well with the application of the irregular doublet law to the sequence Al I to Cl V.

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[1] For references see Moore, C. E., "Atomic Energy Levels", U.S. Nat. Bur. of Stand. Circular No. 467 (1949).
[2] Paschen, F., *Ann. d. Phys.*, **12**, 509 (1932).
[3] Selwyn, E. W. H., *Proc. Phys. Soc.*, **41**, 392 (1929).

A Small Grading Temperature Apparatus for Entomological Use

I HAVE devised an inexpensive grading temperature apparatus (or 'multiple incubator'), especially for a range of below-room-temperatures, for example, + 7°, + 13°, + 17·5° C., which otherwise would require three different refrigerators with thermo-regulation. This is based on the 'Brueckenthermostat' of Zwoelfer[1], and although much simpler, gives excellent results.

The original grading temperature apparatus consists of a copper trough, divided into six (or eight) compartments. One end is welded into an ice-box, the other into a water-bath, in which the temperature is controlled by a thermostat. The copper trough, which is insulated, lies on one side ⊏, and each compartment is closed by a small door, which contains three or four layers of glass. The temperature-range of an apparatus of this construction usually covers the temperatures 7, 13, 17·5, 22, 26·5 and 32° C. Its cost amounts, in Holland, to about £300.

In order to cut costs in materials and man-hours, it was decided to simplify the outlay in several ways: (1) temperatures above mean room temperatures are easily obtained by a simple incubator with thermostatic control; (2) the copper trough is kept upright (⊔), thus preventing cold air flowing from the compartments when the doors are opened, and simplifying the closing mechanism; (3) by incorporating the ice-box and the hot water-bath in the trough itself and not welding it into these parts. The accompanying diagrams show the original construction and the simplified outlay. The cost of the simplified construction amounts in Holland to about £12.

The apparatus is built of 1-mm. copper plate, the upper sides of the trough being set at an angle of 90° in order to strengthen the construction. It contains only four compartments for below-room temperatures, which shortens the apparatus considerably, thus cutting costs for raw material. The trough is placed in a wooden cradle and insulated with 'Excelsior', this being the cheapest insulating material available. The trough is closed with 'Celotex' board, each piece of board covering two compartments. Finally, a blanket is put on top of the whole apparatus. The thermometers, one in each compartment, protrude through the insulation at one side of the cradle.

The ice-box needs filling twice a day, thus keeping the first compartment at 7 ± 0·5° C.; the central compartments show an even smaller deviation. The hot water-bath may be controlled by a thermostat at the temperature wanted. The simplified apparatus, constructed at the Zoological Department of the University of Utrecht, is mounted in a cellar, at a mean temperature of 18 ± 0·5° C., the fluctuations in the apparatus being about the same order, without any thermostatic control being used.

A 15-watt electric light bulb, which is built into the water-bath, keeps the hot side of the apparatus at 25·5° C., giving a range of 7, 13, 17·5 and 22° C.

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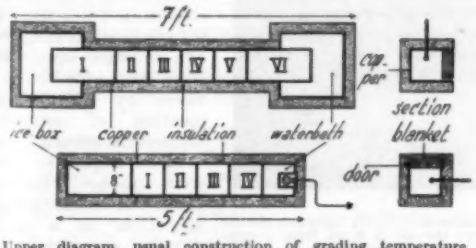
[1] Zwoelfer, *Z. Angew. Ent.*, **19**, 497 (1932).



Upper diagram, usual construction of grading temperature apparatus; lower diagram, simplified construction of apparatus

Statistical Analysis of Results for Successive Tests on the Same Organism

A RECENT paper by Emik[1] demonstrates a method of dealing with counts of trichostrongylid eggs in the fæces of sheep. The method given is fundamentally wrong and in fact makes the paper so misleading that it seems worth outlining a more appropriate statistical treatment. The data were accumulated in a survey of the worm-egg numbers in the fæces of the lamb flock at the University of California. Trichostrongylid eggs were counted in fæces samples by a technique modified from that of Caldwell. Samples were taken once a week for twelve weeks and duplicate dilutions examined.

The counts per 0·02 gm. of fæces (x) were transformed to $\sqrt{x + \frac{1}{4}}$ and the transformed data used to calculate the variance of the differences between duplicate dilution counts. This variance agreed well enough with the theoretical variance, so the next step was to add together the duplicate counts on each sample and transform this total ($x_1 + x_2$) to $\sqrt{x_1 + x_2 + \frac{1}{4}}$. No reason is given for making this new transformation; it does not seem worth the extra trouble involved. The variance of these transformed data was then calculated and analysed.

The fundamental error in this analysis is not uncommon in biometric literature[2,3] and has been attacked by Anscombe[4] and by Cochran[5]; it arises from regarding successive tests on the same animal as independent. The twelve weekly counts on the same sheep have been treated as the items of an independent variate called 'weeks'; the variance has been analysed into a portion due to variation from week to week and into portions due to the interactions of 'weeks' with the main effects. Not only is the assumption of independence a logical error, but also it is quite clear that in this case the 'weeks' portion of the variance consists very considerably of co-variance between one week and the next.

The practical consequences of this error are two-fold, namely, that the error variance becomes too small, giving undue significance to items that are compared with it in the F-test; the second consequence is that the statistician is led into examining factors which have no practical meaning and into making statements such as "the sex × weeks interaction was not significant within the classes, but the class × weeks interaction was significant within the sexes".

On the data given by Emik (Table 1) the appropriate analysis of variance should be the following:

	Source of variation		Degrees of freedom
1	Sex		1
2	Breed and sires		6
	2a Sires within breed	2	
	2b Class of breed	1	
	2c Breed within class	3	
		6	
3	Sex × 2a, 2b and 2c		6
4	Error		87
	Total		100

This should be worked on the average of the transformed egg counts for each sheep; the statistical method appropriate to this set of data is that of 'fitting constants'. Detailed criticism here would serve no useful purpose. One might, however, suggest that the analysis set out above would be illuminated by a table showing the size of the main effects and a graph showing trends during the twelve weeks of the observations. These were not given in the original paper.

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[1] Emik, L. O., *J. Animal Sci.*, **8**, 73–80 (1949).
[2] McQuillan, M. T., Trikojus, V. M., Campbell, A. D., and Turner, A. W., *Brit. J. Exp. Path.*, **29**, 93 (1948).
[3] Swanson, R. G., and Knodt, C. B., *J. Dairy Sci.*, **32**, 257 (1949).
[4] Anscombe, F. J., *J. Roy. Stat. Soc.*, **111**, 181 (1948).
[5] Cochran, W. G., *J. Roy. Stat. Soc.*, Supp., **6**, 104 (1939).

Fruiting of *Coprinus lagopus* in Pure Culture

An isolate of *Coprinus lagopus* from a compost of barley straw was observed to produce sporophores on slants of cellulose agar. The medium consisted of 5 gm. filter paper (Whatman No. 1) treated according to Scales[1] and incorporated in the following:

$NaNO_3$	1·0 gm.	H_2O	500 ml.
KH_2PO_4	0·5 gm.	Agar	7·5 gm.
KCl	0·25 gm.	$FeSO_4$	0·005 gm.
$MgSO_4$	0·25 gm.		

Incubation was at 25° C.

Since agar is known to supply growth substances[2], an attempt has been made to discover some conditions for fruiting in liquid media.

Strips of filter paper were half-immersed in 20 ml. of a solution of the mineral salt constituents of the cellulose agar. After sterilization, the filter paper was inoculated with *C. lagopus* above the level of the liquid, and the tubes incubated at 25° C. Growth was feeble, and after prolonged incubation there was no development of sporophores.

Fruiting of the fungus on the straw of the compost suggested that this material supplied a necessary factor for the process. An extract was prepared by steaming 50 gm. of straw in 500 ml. of water for 1 hr. After being filtered and autoclaved, the extract was incorporated in the solution supplied to the fungus with the filter paper, so that the original mineral salt contentration was maintained.

Development of the mycelium under these conditions was rapid, and after eight days incubation at 25° C. fruiting bodies began to appear. By the seventeenth day the first sporophore in each tube had deliquesced and was fully mature.

It would appear that the extract supplies some factor essential for fruiting of *C. lagopus* under these conditions. An attempt to determine the nature of this factor is now in progress, and details of the work will be published in due course.

D. J. Eastwood

Macaulay Institute for Soil Research,
Craigiebuckler, Aberdeen.
Oct. 8.

[1] Scales, *Zentralbl. f. Bakt.*, Abt. 11, **44**, 661 (1915).
[2] Robbins, *Amer. J. Bot.*, **26**, 772 (1939).

Dispersal of Antherozoids in *Fegatella*

In *Fegatella conica* (Conocephalum) the antherozoids are vigorously dispersed by ejection into the air, and mites, usually considered to be the agents of transmission, probably play little if any part, at least in this member of the Marchantiales. This conclusion is the result of a chance observation made while attending to locally collected material of male plants of *F. conica* which had been transplanted into pans, and had dried considerably during a hot week-end. When watered, a fine mist arose; little attention was paid to this, until it was noticed that the mist was being emitted from the antheridial heads in regular puffs. Removal into direct sunlight increased the activity, and the particles which were being ejected were visible to the naked eye, so that the puffs were obviously composed of distinct granules.

Petri dishes inverted over the material were soon spattered with small droplets, which were found under the microscope to contain numerous coiled antherozoids, many of which were seen to uncoil and swim away in the film of moisture. Repeated collections of droplets were all identifiable as swarms of antherozoids, and it was realized that this explosive method was probably the means of transporting the antherozoids from the sessile antheridial heads to the stalked archegonial heads. Measurements showed that the ejection force was sufficient to perform this function, as antherozoids were thrown 10–15 cm. into the air when undisturbed by lateral air currents. In unscreened plants, however, air currents caused lateral diffusion, so that puffs were much less distinct, indicating that this phenomenon might easily be overlooked in the field.

Antherozoids being vigorously ejected into the air in a jet from a male head (× 6)
(From film by F. Ryan)

Plants were photographed on 16-mm. ciné film, and by careful screening frequent ejection from antheridia were recorded. Further observations showed that: (*a*) temperature was the stimulus to ejection; (*b*) light itself has no obvious effect; (*c*) moisture is a necessary condition for ejection; (*d*) mechanical stimulus can produce weak activity (probably the role taken by mites); (*e*) ejection of complete antheridia occurs.

It is hoped to deal with further observations on such points as these in a more detailed account to be published later.

Note added in proof. Since writing the above, I find that Cavers (1903) gives essentially the same description for this species; so apparently did King (1903). Andersen's (1931) account of a non-explosive type of liberation in *Marchantia* seems improbable, since her observations were confined to sections immersed in water.

K. Benson-Evans

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Botany Department,
University College,
Cardiff.
Sept. 15.

Effect of Microclimate on the Establishment of Timothy Grass

Permanent quadrat studies on the establishment of timothy grass (*Phleum pratense*) and white clover (*Trifolium repens*) in 1947 and 1948 showed that timothy seedlings frequently dried up during hot spells. It was noticed that small seedlings growing close to larger ones or among white clover often remained healthy whereas others surrounded by bare ground died. The apparent explanation, for which support was given by Geiger's[1] work, lay in the protection afforded by vegetative cover. Among other effects cover would lower evaporation from the top layer of soil and prevent temperature and humidity conditions from becoming extreme.

In 1949, dry hot weather set in early, and by mid-June, when the largest late-April-sown seedlings had two or three tillers, many seedlings at the two- or three-leaf stage were dying off in exposed areas. Root measurements showed that the smallest healthy seedlings in the exposed areas had roots of about 2 cm. long. Those with shorter roots averaging 1·7 cm. were dead or dying. In the denser areas the smallest seedlings with roots about 1·6 cm. were quite healthy. Very dense areas where overcrowding introduced another factor are not considered. At this point microclimate studies were started to find out the extent of the protection given by a cover of young tillering plants.

Rough soil moisture figures showed that the top half-inch of exposed soil several times dried out to about 5 per cent water, which was well below wilting point (10 per cent). The top half-inch of covered soil dried out to only just below wilting point.

Soil temperature gradients were studied in both exposed and covered areas. Several typical gradients through different types of cover on a sunny, though windy, afternoon in August are shown in the accompanying graphs.

The main heating effect is seen to occur at the outer active surface or where the sun's rays strike the ground or leaf cover. An example is given in Table 1 of the degree of protection from insolation afforded to the delicate growing parts of young seedlings.

Table 1. Temperature gradients—11.0 a.m.—sunny day, August 22, 1949

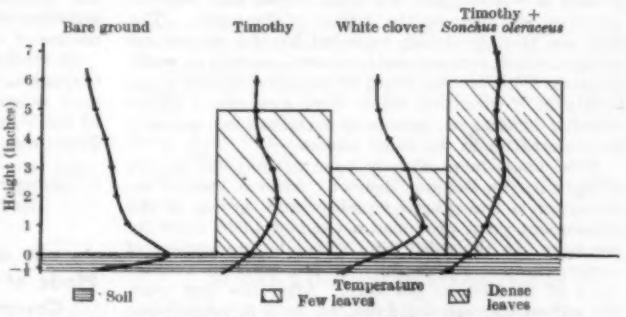
Height	Bare ground	Ryegrass/white clover cover
3 in. above soil surface	28·5° C.	27·8° C.
2 in. " " "	28·8° C.	29·5° C.
1 in. " " "	30·5° C.	27·4° C.
Soil surface	35·0° C.	25·0° C.
½ in. below surface	28·5° C.	23·0° C.

Table 2. Soil temperature in relation to soil moisture

	Percentage water in top ½ in. soil	Temperature		
		1 in. above surface	Surface	½ in. below surface
Bare ground, dry	8·5	27·0° C.	35·9° C.	30·8° C.
Bare ground, watered	15·2	26·7° C.	28·8° C.	26·0° C.

The inter-relationship of moisture and temperature is shown in Table 2 by a comparison of temperatures of an area after three days watering with an unwatered area.

These microclimate studies will be extended in 1950 to include humidity measurements. It can be assumed that there will also be considerable differences in humidity between the exposed and covered areas.



Curves of temperature gradients in vegetation of different heights. August 8, 1949; air temperature at 12 in., 23° C.; sunny; moderate wind

It is not yet possible to determine the limiting factor or factors in the survival of timothy seedlings during drought. It is clear, however, that differences in microclimate between areas with exposed soil and those with plant cover are sufficient to account for the higher mortality among the more sparsely spaced seedlings.

Stella S. Champness

Grassland Research Station,
Stratford-on-Avon.
Jan. 10.

[1] Geiger, Rudolf, "The Climate of the Layer of Air near the Ground", translation from: "Das Klima der Bodennahen Luftschicht" (Braunschweig, 1927).

Reclamation of 'Usar' Lands in India through Blue-green Algæ

While other plants, including crops, fail to grow on the alkaline 'Usar' lands of northern India, blue-green algæ form a thick stratum on the surface of the soil during the rainy season (from July to September) and during the retreating monsoon (December–January). The most important algæ are species of *Nostoc* (*N. commune*, *N. muscorum*, *N. punctiforme*), *Scytonema* (*S. ocellatum*, *S. javanicum*), *Microcoleus* (*M. chthonoplastes*, *M. vaginatus*), *Porphyrosiphon* (*P. Notarisii*), *Camptylonema* (*C. lahorense*), and *Cylindrospermum* (*C. licheniforme*, *C. muscicola*). In

later stages, when the soil is waterlogged, forms like *Aulosira fertilissima*, various species of *Anabæna*, *Cylindrospermum gorakhporense* and *Wollea Bharadwajæ* make their appearance. *Nostoc commune*, which covers many miles, fulfils an especially striking role. The annual addition of organic matter to the soil is of the order of 36·5–59·7 per cent and that of nitrogen, 30–38·4 per cent. Although the nitrogen-fixing capacity of *Nostoc commune* and of other species is still being investigated in bacteria-free cultures, results so far obtained suggest such fixation, which has already been established in certain forms[1–4]. The numbers of *Azotobacter* appear to be considerably reduced in these soils.

The actual process of reclamation is as follows. During May and June, before the commencement of the rains, the land is divided into plots of less than an acre. These are then enclosed on all sides by an earth embankment, 1½ ft. high. After the first showers, the first group of algæ above mentioned appear on the surface, and within a fortnight or so form a thick and compact stratum. Later, when the ground is waterlogged, the algal carpet may become detached and float on the surface of the water. The first are then gradually replaced by the second set of algæ, which continue active growth as long as water remains. This process could be repeated several times in a year if irrigation water were available. Under existing conditions, however, reclamation can only be undertaken in the rainy season.

Field trials have already been carried out in two villages in the Benares district. After a year of reclamation a transplanted paddy crop, grown in the subsequent year, produced a yield of 1,576–2,000 lb. per acre. In the third year a Coimbatore variety of sugar-cane was successfully grown, with an average yield of 30–35 tons per acre. After the first year, the *p*H of the soil fell from 9·5 to 7·6, while there was an improvement in tilth and of the exchangeable calcium by about 20–33 per cent. The water-holding capacity increased by about 40 per cent.

In view of the vast area occupied by such waste lands in the United Provinces alone, the suggested method of reclamation promises to be of immense practical value to Indian agriculture.

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Benares.

[1] De, P. K., *Proc. Roy. Soc.*, B, **127** (1939).
[2] Fogg, G. E., *New Phytol.*, **43** (1944).
[3] Singh, B. N., *Ind. J. Agric. Sci.*, **12** (1942).
[4] Fogg, G. E., *Endeavour*, **6** (1947).

African Elephants as Geological Indicators

During two and a half decades of African bush geology, an observation has forced itself upon me which may perhaps have been noticed by others, namely, that elephants appear to show preference for certain geological horizons. This is at times so well pronounced that the boundary line between two formations can be deduced from native information as to how far elephants circulate in the district. I have noticed it particularly in regions where crystalline rocks, mainly granite masses, come into contact with sandstone, and it is the latter which the elephants prefer.

The first locality, where indeed the boundaries of the granite could be marked according to these observations, was the country between Mouyondzi, Sibiti and Loudima, west of Brazzaville, in the French Middle-Congo, the formations involved being the "Grès de Sibiti", the Upper Kundelungu and the granite mass of Zanaga.

The second district where it was well marked was eastern Oubangui-Chari, towards the border of the Anglo-Egyptian Sudan. Here the escarpment formed by the Ouadda sandstones, generally classified as Loubilashe, formed the definite margin towards the crystalline country of Dar Challa (Ouandadjale).

The third time I came across this phenomenon was in French Adamaua, Northern Cameroons. Here it is the boundary line between the Benoue sandstones and the crystalline and young volcanic rocks of Ngaoundere and Rey-Bouba, roughly 40 km. south of Garua.

In some cases, as to a certain extent within the Forest of Sibiti, where the decomposition of sandstone gives rise to dense vegetation, the question explains itself. Otherwise, however, the country was either tree-savanna or light bush, and in such cases the reason is difficult to explain. It might be a question of food, chemical composition of water or nature of the weathering soil.

It would be interesting to have comments from Central and East Africa, also from the Gold Coast, with reference to the boundary between sandstones of the Voltaian and crystalline rocks of the Northern Territories.

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Mode of Action of Insecticides used for the Control of Apple Sawfly, *Hoplocampa testudinea*, Klug.

Hey and Steer[1] have expressed the belief that nicotine acts mainly as an ovicide when used for controlling apple sawfly, though it is also toxic to the larvæ. They quote, however, other authors who believe that nicotine does not kill the eggs of the sawfly. In an attempt to resolve this conflict of views, ten to fifteen stung blossoms from each of the treatments of a field trial for the control of apple sawfly were examined daily in order to find out at which stage the pest was killed. The treatments, applied in the first post-blossom lime-sulphur spray on May 10, 1949, were as follows: 0·05 per cent nicotine, 0·02, 0·005 and 0·00125 per cent, respectively, parathion (diethyl *p*-nitrophenyl thionphosphate).

No eggs hatched until May 17; peak hatch was on May 19 or 20, and hatching was almost complete by May 23. No larvæ were found dead within the egg in blossoms from any of the treatments, but all were alive and active right up to the point of hatch. After hatching, the effects of the various treatments became noticeable. In the blossoms taken from trees receiving the highest concentration of parathion, the larvæ were found lying dead or moribund near, or within, the remnants of the egg shell. As the concentration of the parathion was decreased, the larvæ lived for progressively longer periods after hatching, and in the case of the weakest concentration two larvæ were found to have entered and burrowed normally. Larvæ in fruitlets from trees sprayed with nicotine were found to burrow normally.

These observations are supported by the data for the sawfly infestations on the recorded trees, which, expressed as a percentage of the total fruit set, were: 50·6 per cent in the controls, and 2·6, 12·9 and 23·9 per cent respectively in the blocks of trees receiving 0·02, 0·005 and 0·00125 per cent parathion. The nicotine sprays gave no control.

It is apparent that nicotine and parathion under field conditions are not acting as ovicides, but kill the larvæ in the period between emergence and entry into the fruit. Thus for successful sawfly control, the insecticide must either be applied as close as possible to peak hatch, or must have sufficient residual effect to cover the whole hatching period. Nicotine is of the first type, and although, in at least some seasons, it may be applied a few days before hatching commences and still give satisfactory control, there is a very small safety margin, especially if it is to be applied in the first post-blossom lime-sulphur spray. It would seem more convenient to choose an insecticide with a greater residual action. It is hoped that details will be published later of work which has been done, and is continuing, at this Station to find which is the best of the new residual insecticides.

K. S. McKinlay

East Malling Research Station,
Nr. Maidstone,
Kent.
Nov. 2.

[1] Hey and Steer, Ann. Rep. East Malling Res. Station, 197 (1933). Steer and Thomas, Ann. Rep. East Malling Res. Station, 194 (1934).

An Enteropneust Genus New to the British Isles

While digging in sandy gravel beyond the apparent low-water mark, on the west coast of Anglesey, during the spring tides at the end of August 1949, a small Enteropneust was found in a burrow of fine sand adhering to a stone. Afterwards several more were discovered in an adjacent, more sheltered region of the shore, where the sand contained a fairly high percentage of organic material.

The animals live in coiled burrows at depths down to four inches, and in association with *Cereus pedunculatus* (Pennant), *Perinereis cultrifera* (Grube), *Arenicola marina* (Montagu), *Notomastus latericeus* (Sars), *Audouinia tentaculata* (Montagu), *Peloscolex benedeni* (O. F. Müller), *Clitellio arenarius* (O. F. Müller).

The primitive condition of the cœlom, namely, one proboscis cavity, two collar cavities, and two trunk cavities, the persistence of dorsal and ventral mesenteries throughout the last two regions, the absence of perihæmal and peripharyngeal cavities in the collar, and of lateral septa in the trunk, of synapticulæ between the gill bars, and of liver diverticulæ, the simplicity of the skeletal system, and of the pharyngeal region, the absence of genital wings and the lateral disposition of the gonads in single rows, justify the identification of this species as one closely related to the genus *Balanocephalus* originally described by Caullery and Mesnil[1] from Saint Martin near Cap de la Hague. Finding this name to have been previously used, these workers gave a detailed description of their species under the generic name of *Protobalanus*[2]. Unfortunately, this too had been previously used for a fossil balanid, so Van der Horst suggested the name *Protoglossus*, under which he summarizes the specific characters in his treatise on the Hemichordata[3].

This find extends the records of Enteropneusta found around the coasts of Britain to six, namely, *Saccoglossus ruber*[4], *S. serpentinus*[5], *S. cambrensis*[6], *S. horsti*[7], *Glossobalanus marginatus*[8], and the new species now recorded.

From my experience of collecting the various British species of *Saccoglossus*, it seems that they favour areas where the substrate contains a fair amount of organic material. Such areas, usually adjacent to beds of *Spartina*, *Zostera* or other shore-living plants, have previously yielded three species of *Saccoglossus*, and if more extensively worked, might well yield more.

A full description of this new species, and of certain species of *Saccoglossus* as yet inadequately described, along with a review of the genus, are to be submitted for publication shortly.

C. Burdon-Jones

Department of Zoology,
University College of North Wales,
Bangor. Oct. 17.

[1] Caullery, M., and Mesnil, F., *C.R. Soc. Biol., Paris*, v, **52**, 256 (1900).
[2] Caullery, M., and Mesnil, F., *Zool. Jahrb., Art. Anat.*, **20**, 227 (1904).
[3] Horst, C. J. van der, "Hemichordata, Bronn's Klassen u. Ordn. d. Tierreichs", **4**, Abt. 4, Buch 2, Teil 2, 658 (1927–39).
[4] Tattersall, W. M., Ann. Rep. Fish., Ireland, Sci., Invest. 1902/3, Pt. 2, App. 7 (1905).
[5] Assheton, R., *Zool. Anz.*, **33**, 519 (1908).
[6] Brambell, F. W. Rogers, and Cole, H. A., *Proc. Zool. Soc. Lond.*, B, **109**, 211 (1939).
[7] Brambell, F. W. Rogers, and Goodhart, C. B., *J. Mar. Biol. Assoc., U.K.*, **25**, 283 (1941).
[8] Meek, A., *Quart. J. Micr. Sci.*, **66**, 579 (1922).

British Freshwater Harpacticids

One of the rarest of the freshwater species of the British Harpacticids is *Canthocamptus bidens* (Schmeil); but it has a very wide distribution abroad. However, until quite recently, the males had never been found either in the British Isles or abroad.

Last June, I discovered a large number of specimens of the species in question in a lake in the grounds of Wellington College, Crowthorne, in Berkshire, and the males were just as abundant as the females.

There has been a considerable difference of opinion over the taxonomy of this species. In 1929 Chappuis created a new genus *Elaphoidella* and placed *Canthocamptus bidens* (Schmeil) in that genus. All taxonomists, so far as I am aware, followed Chappuis, with the single exception of Gurney, who not only disagreed with the creation of the new genus but also pointed out that there was no justification whatsoever for placing *C. bidens* in that genus, especially since the genus was founded almost entirely of the characteristics of the males. The recent discovery of the males and the structure of the fifth foot, among other things, have shown beyond question that Gurney was right so far as the taxonomy of *C. bidens* is concerned.

A description of the male of *C. bidens* is in the press. Full reference to the literature concerned can be found in "British Freshwater Copepoda", vol. 2, by Robert Gurney (Ray Soc. Memoir, 1932) and "Monographie der Harpacticiden", by Karl Lang (Stockholm, 1948).

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, February 27

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (joint meeting with the SCIENCE MASTERS' ASSOCIATION, the ASSOCIATION OF WOMEN SCIENCE TEACHERS, the B.B.C., the NATIONAL INSTITUTE OF ADULT EDUCATION, and the WORKERS EDUCATIONAL ASSOCIATION, at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Discussion on the "History of Science in Education".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Mobile Radio Power-Packs" (to be opened by Air-Commodore R. L. Phillips).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. J. W. Bigger: "Synergism and Anatagonism in relation to Antibacterial Substances".*

INSTITUTION OF WORKS MANAGERS, GLASGOW BRANCH (at the Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank Crescent, Glasgow), at 7 p.m.—Dr. S. I. A. Laidlaw: "Occupational Health as a part of the Provisions of a Public Health Department".

CHEMICAL SOCIETY, OXFORD SECTION (in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Sir John Lennard-Jones, F.R.S.: "Some Unifying Concepts in Chemistry" (Alembic Club Lecture). (All Fellows are invited.)

Tuesday, February 28

INSTITUTE OF SOCIOLOGY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. W. J. Rose: "Antagonism to Strangers—Theory and Fact".

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-WESTERN CENTRE (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Dr. A. C. B. Lovell: "Radar Astronomy" (Fifth Annual University Lecture).

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. L. Milner: "Rhineland To-day".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 7 p.m.—Mr. J. Rhodes: "The Non-Destructive Testing of Metals".

Wednesday, March 1

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. G. E. Blackman: "Selective Toxicity and the Development of Selective Weedkillers" (Inaugural Fernhurst Lecture).

ROYAL SOCIETY OF MEDICINE, HISTORY SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Prof. J. R. Partington: "Van Helmont's Chemical Work in its relation to the Rise of Physiology".

MANCHESTER METALLURGICAL SOCIETY (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. W. Cuthbertson: "Continuous Casting of Metals".

INSTITUTION OF ELECTRICAL ENGINEERS, SCOTTISH CENTRE (at the Heriot-Watt College, Edinburgh), at 7 p.m.—Prof. G. W. O. Howe: "Some Electromagnetic Problems". (To be repeated on Tuesday, March 14, at the Electricity Showrooms, High Street, Rugby, at 6.30 p.m., and on Monday, May 1, at the James Watt Memorial Institute, Great Charles Street, Birmingham, at 6 p.m.)

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the IRISH CHEMICAL ASSOCIATION, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Department of Chemistry, University College, Dublin), at 7.45 p.m.—Prof. M. Stacey: "Deoxy-Sugars and Nucleic Acids".

Thursday, March 2

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5 p.m.—Prof. Alfred Tarski: "Fundamental Ideas and Problems in Meta-Mathematics" (Shearman Memorial Lectures).* (Further Lectures on March 3, 7 and 8.)

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. J. Woodcock: "Some Electrical Methods of Measuring Mechanical Quantities".

ROYAL SOCIETY OF MEDICINE, UNITED SERVICES SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Surgeon-Comdr. G. M. Holford: "Some Aspects of Atomic Medicine".

CHEMICAL SOCIETY, HULL SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, at University College, Hull), at 6 p.m.—Dr. G. M. Bennett, F.R.S.: "Aromatic Nitration".

CHEMICAL SOCIETY (in the Main Chemistry Lecture Theatre, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 7.15 p.m.—Prof. Dr. Pl. A. Plattner (Zürich): "The Azulenes" (Centenary Lecture).

TEXTILE INSTITUTE (at 16 St. Mary's Parsonage, Manchester), at 7.15 p.m.—Gladys G. Clegg: "Microscopical Examination of Fibres from Worn Fabrics".

Friday, March 3

ROYAL ASTRONOMICAL SOCIETY (joint meeting with the GEOLOGICAL SOCIETY, at the Geological Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion on "Gravity as a Geological Factor".

CHEMICAL SOCIETY, SOUTHAMPTON SECTION (joint meeting with UNIVERSITY COLLEGE CHEMICAL SOCIETY, in the Physics Department, University College, Southampton), at 5 p.m.—Dr. H. Irving: "The Determination of Traces of Elements and Compounds".

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Prof. G. I. Finch, F.R.S.: "The Sliding Surface" (Thirty-fourth Guthrie Lecture).

CHEMICAL SOCIETY, SOUTH WALES SECTION (joint meeting with UNIVERSITY COLLEGE STUDENTS' CHEMICAL SOCIETY, at University College, Swansea), at 5.30 p.m.—Prof. F. E. King: "Synthetical Investigations in the Series of Cyclic Imines".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. R. L. Kompfner: "Travelling Wave Tubes".

CHEMICAL SOCIETY, MANCHESTER SECTION (in the University, Manchester), at 6.30 p.m.—Prof. Dr. Pl. A. Plattner (Zürich): "The Azulenes" (Centenary Lecture).

PAPER MAKERS' ASSOCIATION, TECHNICAL SECTION, NORTHERN DIVISION (at the Engineers' Club, Albert Square, Manchester), at 7 p.m.—Mr. E. Langford: "The Functions of Personnel Management".

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the IRISH CHEMICAL ASSOCIATION, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at University College, Cork), at 7.45 p.m.—Prof. M. Stacey: "Bacterial Nucleic Acids".

UNIVERSITY OF LONDON (at Royal Holloway College, Englefield Green, Surrey), at 8.15 p.m.—Prof. A. J. McConnell: "Sir William Rowan Hamilton". (Admission by invitation from the Principal.)

Saturday, March 4—Sunday, March 5

ASSOCIATION OF SCIENTIFIC WORKERS (at St. Pancras Town Hall, Euston Road, London, W.C.1).—Conference on "The World's Food and Britain's Needs".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MATHEMATICS, a LECTURER IN ORGANIC CHEMISTRY, a SENIOR ASSISTANT IN MECHANICAL ENGINEERING, and a LECTURER IN COMMERCE, at the Coventry Technical College—The Director of Education, Council House, Coventry (March 1).

CHAIR OF AGRICULTURE, and a LECTURER IN PHARMACY, at the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 3).

RESEARCH ASSISTANT for investigations on bone histology—The Registrar, The University, Liverpool (March 4).

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. F.51/50A), research chemist, or biochemist with analytical experience, for experimental work on food processing, a SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (Ref. G.14/50A), research microbiologist for experimental work on food processing, an EXPERIMENTAL OFFICER (Ref. F.52/50A), chemist or biochemist with analytical experience (preferably of foodstuffs) for experimental work on food processing, an EXPERIMENTAL OFFICER (Ref. G.15/50A), microbiologist for experimental work on food processing, an EXPERIMENTAL OFFICER (Ref. F.53/50A), food chemist with general factory experience, for development work on food processing, at the Ministry of Food, Aberdeen—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 4).

ASSISTANT IN BIOCHEMISTRY (preferably a chemistry graduate with some postgraduate experience in biochemistry)—The Dean, British Postgraduate Medical Federation Institute of Orthopædics, 234 Great Portland Street, London, W.1 (March 15).

OFFICER-IN-CHARGE, Commonwealth Research Station, Merbein, Vic. (No. 2728), work chiefly concerned with investigations into the many phases of viticultural and citrus production in the Mildura and surrounding area, and a SENIOR RESEARCH OFFICER (microanalyst), Division of Industrial Chemistry, Fishermen's Bend, Melbourne (No. 2711)—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 18).

LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The University, Edinburgh (March 31).

DIRECTOR (with an honours degree in engineering and corporate membership of the Institution of Civil Engineers or Mechanical Engineers) in the Ministry of Supply, Division of Atomic Energy (Production), at Risley—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

HEAD OF THE CHEMISTRY DEPARTMENT, and a SENIOR ASSISTANT (male) well qualified to teach chemistry, particularly physical chemistry, to degree standard, and with industrial experience, at the Municipal Technical College—The Chief Education Officer, Education Offices, Nelson Square, Bolton.

LECTURER, and an ASSISTANT LECTURER AND DEMONSTRATOR, in the Department of Physiology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

RESEARCH BURSARY IN THE DEPARTMENT OF ENGINEERING—The Registrar, The University, Nottingham.

SENIOR ASSISTANT (Biology), and a GRADUATE ASSISTANT (Physics), at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

SOCIAL ANTHROPOLOGISTS, URBAN SOCIOLOGISTS, a DEMOGRAPHER and a HISTORIAN—The Director, Rhodes-Livingstone Institute, Box 195, Livingstone, Northern Rhodesia.

TSETSE CONTROL OFFICER by the Government of the Gold Coast—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.23338 (3F).

DEPUTY CHIEF ENGINEER to act as deputy to the Director (Chief Engineer) responsible for the design and layout of large chemical factory installations—The Ministry of Supply, Division of Atomic Energy (Production), Risley Warrington, Lancs.